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ABSTRACT

The learning of different school subjects (history, English, poetry appreciation, creative writing, reading, elementary school mathematics, geography, and modern languages) can be evaluated qualitatively, using the Structure of the Observed Learning Outcome (SOLO) Taxonomy. The taxonomy is structured into five major levels, with transitional responses sometimes identifiable between levels: (1) pre-structural; (2) uni-structural; (3) multi-structural; (4) relational; and (5) extended abstract. These hierarchical levels reflect the quality of learning of a particular episode or task. This taxonomy is particulary well-suited to the receptive learning of a finite display of information (for content analysis, such as a prose passage) or of a complex set of skills (for process analysis, such as mathematical problem solving). (Several implications for curriculum, instruction, and evaluation are discussed.) (Author/GDC)

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CLASSROOM EXAMPLES OF COGNITIVE DEVELOPMENT PHENOMENA: THE SOLO TAXONOMY

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CLASSROOM EXAMPLES OF COGNITIVE DEVELOPMENT PHENOMENA: THE SOLO TAXONOMY

K.F. COLLIS and J.B. BIGGS

Report prepared at Conclusion of an Educational Research and Development Committee funded project.

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PREFACE

Conventional means of reporting psychological research which has application in classroom practice has not attracted an audience which normally includes the classroom practitioner. Consequently the practitioner often has little knowledge of the significance of recent developments in cognitive theory in terms of classroom methods and programmes.

The original aim of this project was to give teachers (and curriculum workers) actual classroom examples of levels of cognitive development which they would recognise from their dealings with classroom situations. This was to be done across several curriculum areas, namely, mathematics, english, history, geography, economics and modern languages, using exemplars obtained from previous research, from practising teachers, and from original surveys conducted in schools.

The project aimed at being a development project rather than being concerned with fundamental research. It was hoped that it would contribute to teacher development in at least two ways. First, it should provide the teacher with a basis for realistic expectations of his students' cognitive processing capacity at various age/stage levels. Second, it should direct the teacher to tune in to and to take heed of a student's responses as an indicator of cognitive functioning level.

The method envisaged to achieve these aims involved six sequential phases:

(i) a review of the literature to find items in this context in the various content areas;

(ii) obtaining suggestions for items from curriculum and method study experts in the various content areas;

(iii) obtaining suggestions for items from practising classroom teachers specialising in the different content areas;

(iv) field trials of some of the items gathered as indicated above;

(v) selection of examples which show basic theory best and which teachers might find meaningful in terms of their experience;

(vi) writing report(s) which would show how the basic theory relates to particular content areas.

As the project developed two problems caused the authors to modify their original expectations. The first was that the feed-back obtained from the literature, the teachers and the children showed that we would need to focus our attention on response structure rather than developmental stage. The reasons for this are set out explicitly in the Introductory

Statement at the beginning of the report proper. The second problem arose because most of the persons whom we canvassed with early drafts on their content areas - drafts based on the literature review - wanted to use them as they were. They saw the bringing together of the material on cognitive development levels in a way which related directly to their content area as very relevant and most useful. Most gave us this positive feed-back but little help in pointing to gaps in the item bank so far as their content area was concerned. As the authors were not expert in all the disciplines which we had set out to cover we found ourselves limited in the variety of items which we could use in some content areas. This of course means that the work reported in the following pages is seminal rather than comprehensive.

This seminal approach has two consequences. First, each section of the report has strengths in some directions but omissions in others. Second, although each section, and each sub-section in the case of Section C, will stand alone as a contribution to understanding cognitive phenomena in the classroom, the work reported in each section is meant to lay the ground-work for a more comprehensive study of the particular area.

It is clear from the outline given above that, in the course of this project, the authors have called upon the services of colleagues, research assistants, students and practising teachers to obtain and analyse the wealth of data necessary in a project of this nature. We gratefully acknowledge such assistance, and would like to mention in particular the following:

Margaret Bowers, Diana Campbell, Elizabeth Campbell, Dot Jensen, Warren Johnson, Yvonne Larssen, Wend Lou McLaughlin, Shelley Phillips, Louise Preston, Lindy Taylor, Penny Sara, Don Margetson, John Annells, Freddie Dayan, Patricia Combes, Diana Bennett and Shirley Grosvenor.

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CLASSROOM EXAMPLES OF COGNITIVE DEVELOPMENT PHENOMENA: THE SOLO TAXONOMY

ABSTRACT

The aim of this report is to describe to teachers qualitatively different levels of judgment and reasoning ability as they apply to the teaching of different subjects in the school curriculum. We distinguish five such levels, and it will be seen how students' responses show an increasing complexity of structure from lowest to highest levels, corresponding in some ways to the stages manifested by individuals in their general intellectual development. A classificatory scheme or taxonomy is described, by which means it is possible to code students' responses to various kinds of items in terms of these five levels. The taxonomy is based on the structure of the observed learning outcome which the student gives to the item, and so for convenience we call it the SOLO Taxonomy. It is in effect a means by which an important aspect of the quality of the student's learning and thinking can be gauged. Some suggestions about how teachers may use the taxonomy are also discussed.

After an introductory statement this report is divided into four sections:

A: Theory and general characteristics of the SOLO Taxonomy.

B: Some general implications for teaching.

C: Examples of the Taxonomy in use in particular subject areas, with some implications for teaching.

D: Bibliography.

INTRODUCTORY STATEMENT

The present research originated in an attempt by Collis and Biggs (1976) to find examples of levels of cognitive development in the major teaching subjects at high school and make them available to teachers. It was hoped for example that teachers might recognize students' errors as natural developmental phenomena, rather than as "carelessness". How and why we shifted from this pure developmental point of view to our present position is outlined in this introductory statement.

Much previous work had been done in this area, in particular by Peel (1971) and his students. Such work had covered the development of children's thinking in the areas of history (e.g. de Silva, 1972; Hallam, 1967, 1969 & 1970; Jurd, 1975), mathematics (Collis, 1975a; Lovell, 1971), geography (Rhys, 1972), English literature (Mason, 1974), and science (Shayer, 1976; Shayer, Kuchemann & Wylam, 1976).

At first, relying heavily on this previous research, we attempted to construct a general taxonomy that could be applied across subject areas, the original hope being to produce a check-list for teachers, so that they could code their own student's responses in terms of developmental level. However, as we progressed, trying to classify particular examples of children's productions from the fields of mathematics, geography, English, history, economics and modern languages, certain difficulties became apparent:

1. The criteria used by the various researchers for determining different developmental stages differed considerably across subject areas. Comprehension of inverse operation, and multiple interacting systems, for instance, while crucial in logico-mathematical tasks, seemed irrelevant in other areas; while obvious "quality" in English, marked for instance by the appreciation of metaphor, appeared inapplicable elsewhere. In other words, we were finding a certain amount of content specificity which was hard to reconcile with the notion of a child being "at" a particular stage. At the same time, however, some general criteria for categorising levels of response across subject areas were found: these are outlined later.
2. When we began testing our own subjects on items from the various content areas we found that décalages became very much the rule, not the odd exception to an even developmental growth. Not only were preoperational and early concrete responses very common amongst high school adolescents (and even amongst university students), the level

of responding was highly unstable across subject areas; the same student ranging from preoperational in English say, to formal in mathematics. Worse, the same student could vary three and even four stages in the same subject area. Consequently, age ranges for typical responses became too gross to accommodate usefully in the traditional stage development scheme.

3. In addition we found occasional inconsistencies in the same student's response upon retesting on the same item. For example a student might respond at the middle concrete level and then when retested weeks later give responses one and two levels higher than the level at which the material was originally encoded.

Such considerations caused us to call into question the notion of categorizing students into developmental levels on the basis of their responses to particular items in particular content areas. On the other hand, we could see that to achieve our purposes we needed to shift the focus away from a response implying a stage of development to a consideration of the quality of each individual response per se. As is explained in Section A of this report, stage of development seemed to us to imply a relatively stable characteristic (like I.Q.) whereas to satisfy our aims we needed to provide a key to the quality of a response at a particular time (like a score in an informal classroom test which might vary from day to day depending upon factors other than stage of cognitive development - factors such as emotional state, physical state and motivation).

We feel that the Taxonomy which we have devised offers a useful way of analysing what is meant by quality of response. Such an analysis seems to us to be highly relevant to teaching, as, from a different conceptual framework, is the Bloom Taxonomy (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956).

These points may best be illustrated by reference to an example that particularly highlights the problem. First, let us delineate the minimal criteria differentiating the five critical stages* of cognitive development met in school age children by using a task which requires the student to demonstrate his understanding of a finite set of information or data (a story, a poem, an explanation of a concept or principle) in terms of how well he has assimilated the data, their inter-relationships and their possible relevance to other concepts.

1. Preoperational. A response based upon a lack of comprehension; tautology, an irrelevant association, or denial of the data.

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* The stages are adapted from Piaget by Collis (1975a), the major modification being the extension of concrete operations into the early formal stage.

2. Early concrete. One relevant point is seen, but others are missed.
3. Middle concrete. Several relevant points are noted but in isolation.
4. Concrete generalization. The relevant dimensions of the data are perceived and their interrelationships. The response is however still tied to the immediate content, as is the case in the preceding levels.
5. Formal. A superordinate, abstract principle is brought in to enable valid generalizations from the given, with extensions to novel data. There is reluctance to close on a unique answer.

These are, as noted, minimal criteria: a full tabulation is given in Collis and Biggs (1976). Nevertheless, the above is sufficient to enable us to go on to the second stage of the illustration, the example.

This particular example comes from the work of Marton and Saljö (1976), who were interested in the quality of learning exhibited by undergraduates at the University of Gothenburg. Marton and Saljö hold a radical, atheoretical and existential view of learning: the quality of learning is displayed solely in the content, so that the quality of the student's understanding is assessed in terms of what he gets out of the material. However, it so happens that their criteria of quality of response are virtually identical with a Piagetian analysis carried out along the lines outlined above. The stimulus material Marton and colleagues gave students was of the same kind as that used by Peel and by ourselves - the student has to demonstrate his understanding of a finite set of data. In short, despite the theoretical differences, Marton's work is (on this point) directly comparable with our own.

When Marton classified his students' responses according to quality, it turns out that his Level A is identical to our concrete generalization; Level B to middle concrete; Level C to early concrete; Level D to preoperational (the details appear in Biggs, 1979a).

Undergraduates were classified into the various levels as a result of testing on one occasion. Six and a half weeks later they were re-tested and a level was determined on the second occasion. There was considerable evidence of décalage: of the eight students who gave concrete generalization responses, five dropped to middle concrete on retesting; of the 21 students who gave an early concrete response on the first occasion, two gave a concrete generalization or better response on the second occasion.

While such results may not be surprising from a common sense point of view, they are surprising indeed from the stand-point of developmental psychology. Décalages, instead of being the exception, become the rule. In short, it seems that when we are looking at the results of particular

learning studies, we are not talking about a quality of the student - as are Piagetians when they classify the students as early concrete, middle concrete or concrete generalisation - but about a quality of the learning obtained on a particular task. It thus appears vital to distinguish between the developmental base level from which the child is operating at any given time, and the structure of the outcome of his learning a particular content task. We decided that what Peel et al and ourselves were really doing when we looked at responses from particular content areas was looking for a way of assessing learning outcomes, and these are only partly dependent upon developmental levels of individuals. For our purposes here then level of development takes on the status of a hypothetical construct: something which might help to explain present performance, but, as far as the teacher is concerned, it is unobservable and probably not measurable. Thus we would hope to assist the teacher in focussing his attention on the immediate outcome of learning, vis-à-vis the particular learning task rather than attempting to categorise children according to development stages. Both in the long and the short term this appeared to us to be the most productive approach.

In summary then we are saying that there are in fact two domains. On the one hand, Piaget and others have pointed out that the growth of thought proceeds from sensori-motor actions, through various stages, to the complex structure of formal operations. These internalized stages we may call the hypothetical cognitive structure (HCS) (Biggs, 1979b),which is a property of the individual. On the other hand, educators have noted that students' responses to a learning task proceed from simple repetitions of the given, to complex structures that go beyond the particular information given and that may display elegance, deftness, surprise and beauty. We may call this domain the structure of observed learning outcomes, or SOLO, which is task specific.

In this report, then, we are concentrating on the latter domain, i.e. on the quality of the particular responses given to specific learning or problem solving tasks. Developmental issues are dealt with only incidentally.

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SECTION A

THEORY AND GENERAL CHARACTERISTICS OF THE SOLO TAXONOMY

Section A: Theory and General Characteristics of the SOLO Taxonomy

Reasoning and Judgment in School Learning

Virtually all school tasks involve learning of some kind; it might be rote learning, the learning of skills, meaningful learning, learning by discovery, learning of established bodies of knowledge, learning values and attitudes, or learning how to get on with others. We are concerned here only with the meaningful learning of existing knowledge; and in particular with the reasoning and judgment the student displays in using that learning. While this does not of course cover all school learning, it remains a very important part of school learning.

Let us take an example. Say a lesson has just been given on the formation of rain, and the question is asked: "Why is the side of a mountain that faces the coast usually wetter than the side facing the interior?" The following responses may be observed:

1. "Because it rains more on the coastal side."
2. "Because the sea breezes hit the coastal side first."
3. "Because the sea breezes contain water vapour and they first strike the coastal side and so it rains on them and after that there's no rain to fall on the other side."
4. "Because the prevailing winds are from the sea and they pick up moisture and as they meet the mountain they're forced up and get colder, the moisture condenses, forming rain. By the time the winds cross the mountain they are dry."
5. "This is likely to be true only if the prevailing winds are from the sea. When this is so, the water vapour evaporated from the sea is carried to the mountain slopes, where it rises and cools. Cooling causes the water vapour to condense and deposit. Not only is the wind now dryer, it is then carried up the mountain further, is compressed, now warms, and thus is relatively less saturated than before: the effect is similar to the warm climates experienced on the Eastern slopes of the Rockies in Canada in winter. However, all this makes assumptions about the prevailing wind and temperature conditions; if these were altered, then the energy exchanges would differ, resulting in quite a different outcome."

Pretty clearly, these responses are increasingly better in quality. The first is not incorrect, but it tells you nothing about the quality of learning: it could have been given by a student who hadn't learned anything from the lesson. The second presents one relevant fact, the third several; neither gives an adequate explanation. The fourth response gives an interconnected and logical explanation; but as the fifth response makes clear, it could be an incorrect overgeneralization. The fifth response considers all aspects, including some not given in the original lesson (let us assume); it introduces general abstract principles that cover both

this situation and others; and it considers alternative possibilities to that implied in the question.

In short, we have here a learning situation, followed by a judgment which uses that learning. The SOLO Taxonomy is designed to describe the structure of such responses, and it may then be seen what the characteristics of the higher level responses are. The Taxonomy is based upon the principles of cognitive development and we will now turn to a brief consideration of these.

General Intellectual Development

Most psychologists agree that when an individual learns something, he interprets it in terms of his existing thought structures. These structures are modified and extended according to the demands placed upon the learner. By so modifying his thought structures, he constructs an increasingly complex system of rules of thinking: some rules are general, applying to a variety of situations, while others are specific to the subject matter learned. While this process is continuous from infancy to adulthood, certain general stages of cognitive development have been distinguished, most notably by the Swiss psychologist, Piaget.

Since this report refers to school-age children, the stages of cognitive development outlined here range over that period of intellectual growth only. The five categories which we have used to describe the stages in children's judgment and reasoning ability are adapted from Piaget by Collis (1975a):

(1) pre-operational stage (5 to 6 years)*
(2) early concrete operational stage (7 to 9 years)
(3) middle concrete operational stage (10 to 12 years)
(4) concrete generalization stage (13 to 15 years)
(5) formal operational stage (16 years onwards).

The development from pre-operational to formal operational runs the gamut from the judgment of a situation made on the basis of superficial appearances to one based on highly abstract principles: this progression can be traced in responses (1) to (5) in the example on rain formation given above.

It is generally agreed that the chronological ages corresponding to the stages vary a great deal from culture to culture and from individual to

* It should be made perfectly clear that the age ranges quoted here are done so on the basis of stage of development usually reached by the average child. They are by no means prescriptive and are not meant to over-ride what we know to be an enormous range of individual differences in intellectual development; some few 10 year olds for example, being formal operational while some 16 year olds demonstrate quite clearly that they are still at the middle concrete stage in general cognitive functioning.

individual, but that the order of succession of the stages is constant. The age levels attached to each stage are, as mentioned in the footnote, only given to orient the reader to the approximate grade level of the children concerned. Further, the stages do not refer to the average level of cognitive functioning of the child, but rather to the optimum capability of thought at the given period in his development. It is important to note that an individual may operate at or below this optimum depending on the situation. Adolescents can and do give responses that can be classified as pre-operational. Examples of each level of functioning can be found from the upper primary to the upper secondary school, although responses at the higher levels are more common in the later years of secondary school. The nature of the task and the student's familiarity with and training in the task also help to determine the level at which the student will operate on any given occasion.

Piaget observed his stages of cognitive development under rather "ideal" conditions involving individual testing on quite clear-cut tasks involving general logical concepts, and so his stages tend to outline the upper limit of intellectual functioning. When we take performance in school subjects that require specific knowledge, we get rather a different picture.

Performance in School Subjects

The average classroom contains children of different abilities and interests in the subject being taught. Some children might have a faulty understanding of basic pre-requisite concepts; the quality of teaching can vary tremendously; classroom tests are usually carried out on a group basis; and classroom tests often incorporate items worded so that higher order levels of thinking and judgment are not specifically called for. For these, and other, reasons teachers will find that high school students (and in our experience university students too) not infrequently perform at a disappointingly low standard in terms of Piaget's developmental criteria.

Nevertheless cognitive psychology has a lot to offer teachers wishing to understand, and to improve, children's thinking in particular school subjects. It is not just a matter of getting students to give the "correct" response to an item: many responses can be "correct" in some sense, but some responses are clearly of a better quality than others. This qualitative difference is often meant to be reflected in grading. A mark of "A" or "Credit" reflects the fact that an essay, or other test performance, is better than one that gains a "C" or "Pass" response - both might be technically correct. We do not mean that this difference simply implies that the Credit student has answered with more recalled items of inform-

ation, but that the better response has a more complex structure. In short, the structures that Piaget observed in responses to his tasks may be used as a basis for evaluating many kinds of school task.

One kind of task that is well suited to this kind of analysis is that referred to earlier: where a specific, finite set of information is given (a story, a problem in mathematics, a set of data describing and explaining a concept or principle, a poem) and on the basis of his prior learning the student has to answer comprehensive questions showing how well he has understood the data, their inter-relationships, and their possible relevance to other concepts.* One would expect that under ideal conditions - one-to-one testing, high motivation, etc. - the structure of the observed learning outcome (which for convenience we shall call the SOLO level), given by a student, would be equivalent to his stage of cognitive development. Often, however, the SOLO is far below the expected level. In order to maintain the distinction between stage of cognitive development, and level of structure of learning outcome, we have used different terminology to describe the latter.

The relationship between the student's stage of cognitive development, and his corresponding SOLO level for any given task, may be understood by the analogy of the relationship between his IQ and his attainment in any particular subject. IQ refers to a characteristic of the student that generalises across many tasks; it is relatively stable and is (effectively) independent of instruction. Attainment refers to the result a student obtains in a particular test about quite circumscribed learning material; his attainment score will vary considerably from occasion to occasion and from subject to subject, depending upon the amount and quality of instruction, particular interest in the subject in question, etc.

Similarly, then, a student's stage of cognitive development describes (as in this sense does IQ) a relatively stable characteristic; he may be described as a concrete generaliser, pre-operational reasoner, and so on. However, it does not make sense to call him an "extended abstract" or a

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* The solving of written problems in elementary mathematics fits this pattern well but there is another side to elementary mathematics learning - the ability to understand and work within the number system as such. This latter ability follows a developmental sequence isomorphic to that which is described here in relation to more general content areas and thus responses are readily analysed using the same technique. Moreover the general comments in both this section and the next can be seen to apply directly to all aspects of elementary mathematics as taught in school. However, for the sake of clarity for the general reader, mathematics examples are not interspersed throughout the general sections of this report but reserved for the appropriate part of Section C.

"pre-structural", in just the same way as it does not make sense to refer to a student as "a nine-out-of-tenner" or "a twenty percenter". Such terms refer to an immediate and particular test result, which is what a SOLO response is.

This distinction, between describing responses as opposed to people, is important, because teachers who know their Piaget often find it difficult to understand why a child, who "should" be formal operational on the basis of his age or performance in some tasks, appears to be concrete operational in English, or even pre-operational in mathematics. It is because of the possibility of this kind of confusion between general stages of development and particular test results that we have introduced our own terminology; the SOLO terminology implies a warning not to over-generalise. For example, a "uni-structural" response is just that - a response that contains one relevant concept, dimension or datum, out of all those the student could have utilised.

The relationship between cognitive development and SOLO, and the general characteristics of the latter, are outlined in Table 1 (see next page). At the extreme left is given the developmental base stage, in Piagetian terms, with the minimal age level at which the stage usually occurs. Next follows the name we have given to the SOLO level of response that is isomorphic with but not identical to the corresponding developmental stage, and the following columns marked 1 to 4 describe the characteristics of each SOLO level.

1. Capacity refers to the availability of "mind-space", or more technically, working memory, that the different levels of SOLO require prima facie. Functional working memory capacity increases with age, as does the space required for higher level responses.*

A quick glance at the rain formation responses (p.11, above) will confirm that the student giving response (5) has to keep more things in mind, while the

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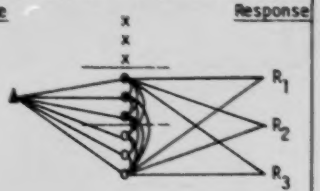
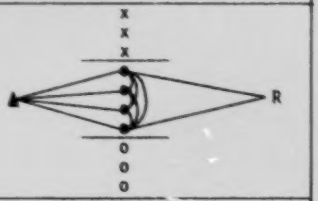
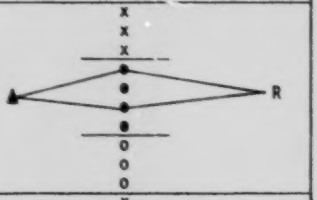
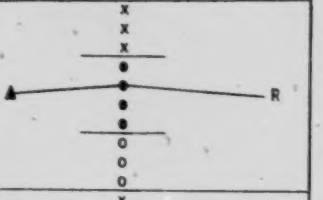
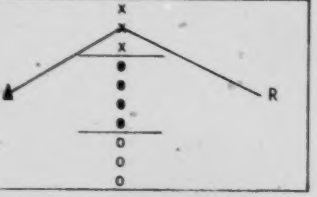
* Whether working memory actually increases with age, or whether increasing capacity is a function of the automaticity of the response within fixed working memory, is a debatable issue. McLaughlin (1963) and Pascual Leone (1972), for instance, believe that the capacity of working memory increases with age up to adolescence. Case (1979), on the other hand, believes that working memory is constant across ages, but that with increasing experience, certain data become automated thereby taking up less space within fixed capacity, thus leaving more space for higher level responses. The evidence so far probably favours Case's position but it would be inappropriate to go into this here. Certainly, it seems reasonable, and in keeping with all experimental findings to date, to suggest that higher level responses are dependent upon a great deal of experience at the preceding level. This point will be brought out in the appropriate places later in this report.

TABLE 1

Base Stage of Cognitive Development and Response Description

Developmental Base Stage with Minimal Age	SOLO Description	1 Capacity	2 Relating Operation	3 Consistency and Closure	4 Possible Response Structure
Formal Operations (16+ years)	Extended Abstract	Maximal: Cue + relevant data + inter-relations + hypotheses	Deduction and induction. Can generalize to situations not experienced	Inconsistencies resolved. No felt need to give closed decisions - conclusions held open, or qualified to allow logically possible alternatives. (R_1, R_2 or R_3)	
Concrete Generalization (13 - 15 years)	Relational	High: cue + relevant data + inter-relations	Induction. Can generalize within given or experienced context using related aspects	No inconsistency within the given system, but since closure is unique so inconsistencies may occur when he goes outside the system	
Middle Concrete (10 - 12 years)	Multi-structural	Medium: cue + isolated relevant data	Can "generalize" only in terms of a few limited and independent aspects	Although has a feeling for consistency can be inconsistent because closes too soon on basis of isolated fixations on data, and so can come to different conclusions with same data	
Early Concrete (7 - 9 years)	Uni-structural	Low: cue + one relevant datum	Can "generalize" only in terms of one aspect	No felt need for consistency, thus, closes too quickly: jumps to conclusions on one aspect, and so can be very inconsistent	
Pre-operational (4 - 6 years)	Pre-structural	Minimal: cue and response confused	Denial, tautology, transduction. Bound to specifics	No felt need for consistency. Closes without even seeing the problem	

KEY: Kinds of data used: x = Irrelevant or inappropriate • = Related and given in display o = Related and hypothetical, not given.

student giving response (1) has only to remember the question itself. Thus, a pre-structural response makes least demands: one "bit", the cue (i.e. the question) and response are confused into one global undifferentiated unit. The simplest correct response requires separation between the cue and one relevant aspect to form the response. In other words, in order to answer the question adequately, the student must, at the least, bear the question in mind while he is answering, and then try to relate the question and the answer in mind while he is answering, and then try to relate the question and the answer with at least one logical operation. Thus, response (2) is uni-structural, as it can be seen that it relates one relevant datum to the question: hence the capacity required is that which enables the handling of two "bits" (cue + one relevant datum). A multi-structural response (see response (3)) involves two or more concepts or data; a relational response (4) goes further and interrelates the concepts, so that in this case we have the cue + most or all relevant data + their inter-relationships. The extended abstract (5) goes even further than that; the student here needs not only to encode the given information, but to comprehend its relevance to over-riding abstract principles, from which he can deduce a hypothesis, and apply it to a situation that is not given: all of this obviously requires a larger memory capacity than the other SOLO levels.

2. Relating operation refers to the way in which the cue, and the aspects of the response, relate together. In the case of the pre-structural response there is no logical inter-relation; the cue and response are fused into one tangled unit. There are three types of pre-structural confusion. Denial is the simplest, by which the student refuses to become seriously engaged in the task: he might say "That's dumb", "Dunno", or simply guess. Transduction is slightly more complicated - as represented in the SOLO Taxonomy it is more a "guesstimate" than a guess - in that the student attempts to differentiate a relevant response but slips up because he does not form an adequate logical basis for his selection of a response. Instead he makes a jump on a perceptual or emotional basis, taking as relevant what strikes him most forcibly at the time. For example: Q. "Why did the Rum Rebellion take place?" A. "Because all the men were drunk all the time". Possibly - but the answer is really irrelevant, the student having transduced from the particular dominating cue "rum" to an obvious association with rum, "drunk". Tautology simply restates the question, e.g. "Because they were rebelling about rum" (see also response (1) on page 11). Tautology should not be confused with rote learning, which involves repeating the original

data verbatim - this might well involve a correct, but limited, answer to the question, whereas restating the question obviously can never be adequate. The reader will be aware that these phenomena, associated here with pre-structural responses, may be used deliberately by sophisticated reasoners who wish to avoid answering a question.

Induction involves correctly drawing a general conclusion from particular instances; or in the present context, relating a particular aspect or point given in the data to a conclusion. A uni-structural response, then, involves ascribing the Rum Rebellion to just one of the several relevant features that caused the Rebellion; or rain to only one of the relevant features. A multi-structural response faithfully marshalls several of the relevant features, but fails to link them up. The multi-structural response typically contains "... and ... and ... and ...". The relational response gives an overall concept or principle that accounts for the various isolated data that the multi-structural response contains, but sticks within the data and concepts already taught about the formation of rain, or within the framework of the Rum Rebellion, in early colonial Australia.

The extended abstract response goes beyond induction on the basis of the data and introduces true logical deduction: "Yes, the problem was an imbalance in the currency system coupled with X, Y and Z. Now, if balance of payments had been established on the basis of the Colony's productivity, then the outcome might well have been different. In the analogous case of the settlement of the Hudson River ..." (see also response (5) above on rain). There are several features about the extended abstract response that should be noted: (i) the introduction of an abstract principle (balance of payments; principle of heat exchange) which was not given directly in the data; (ii) the deduction from that principle that certain events would follow; (iii) the introduction of an analogy (Hudson River settlement; the Rockies in Canada) which was compatible with that principle but likewise not given in the data; and consequently (iv) the outcome may be indeterminate, i.e. there is an absence of closure (events might have been different under different circumstances).

3. Consistency and closure refers to two opposing needs felt by the learner: one is the need to come to a conclusion of some kind (to close); the other is to make consistent conclusions so that there is no contradiction either between the conclusion and the data, or between different possible conclusions. The greater the felt need to come to a quick decision the less information will be utilized, so that the probability

that the outcome will be inconsistent with the original cue, the data or the outcome, is increased. On the other hand, a high level of need for consistency ensures the utilisation of more information in making a decision, so that the decision is likely to be more open.

The pre-structural response is marked by very high closure and very low consistency: in fact, the student at this level closes by simply saying "I dunno", repeating the question, or by transducing across some irrelevancy. The student who gives a uni-structural response seizes upon the first relevant dimension that comes to mind - but at least it is relevant. Uni-structural responses can all be equally correct, but quite inconsistent with each other, rather like the blind men describing the elephant: the elephant was described as a piece of rope, a wall, a snake, a tree trunk, all correctly, given the perspective of each man.

In multi-structural responses, closure is determined when more aspects are received, but as these aspects are not inter-related, inconsistency may result.

The student responding relationally waits until he sees all the aspects and then inter-relates them to make a coherent whole, but he will come up with a definite answer (closure) and while this might be an excellent answer for that context, it will not do for other contexts - i.e. an over-generalization may be made. The relational response is still tied to concrete experience: it leaves room for inconsistency <u>across</u> contexts. For example, the factors that produce coastal-side rain may not always apply; or the factors that add up to Australia's Rum Rebellion may not be applicable to apparently similar rebellions in other colonies. The extended abstract response on the other hand, sets out principles and heavily qualifies their application to a particular situation, i.e. consistency is maximal, and, as a result, the student may feel it appropriate to leave the question relatively open.

4. <u>Structure</u> is an attempt to represent these characteristics in diagrammatic form. The student may respond to the cue by using three types of data: (i) irrelevant data (represented by <u>x</u>); (ii) related data which are contained in the original display, i.e. lesson, prior information etc. (represented by •), and (iii) data and principles which are not given but which are relevant, hypothetical and often implicit in the data (represented by o).

At the pre-structural level there may be an attempt to link the cue with the response by an irrelevant feature. The uni-structural response takes one relevant datum or feature to link the cue and response; the multi-

structural response takes several. The relational response ties up the relevant data in a conceptual scheme. The extended abstract response takes up all the relevant data and their inter-relations and subsumes them under a hypothetical abstract structure which can enable deductions to apply to instances or data which weren't included in the original display. Consequently, the student giving an extended abstract response can entertain alternative outcomes: he is not forced, as others, to come to a definite closure or conclusion.

Transitional Responses

It is sometimes found that responses do not fit exactly into the above five levels. Transitional responses can occur when the student is feeling for the next level, but doesn't quite make it: transitional responses tend to be marked by confusion or inconsistency. It is as if the student is handling more information than he can cope with in his working memory, and he loses track of his argument. Typically, transitional responses carry more information than is usual in the level the student is emerging from, but he is forced to give up before reaching the complexity of structure that is expected at the next SOLO level. Because of this confusion or inability to reach closure, a well-formulated transitional response at a lower level can be mistaken for an extended abstract response, which likewise doesn't reach closure but for a very different reason.

Transitional responses are referred to as 1A (from pre- to uni-structural), 2A (from uni- to multi-structural), 3A (from multi-structural to relational) and 4A (from relational to extended abstract). Examples of these and further examples of the basic SOLO levels will be outlined as appropriate in Section C. In the following Section, we deal with some general implications of the Taxonomy.

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SECTION B

SOME GENERAL IMPLICATIONS FOR TEACHING

Section B: Some General Implications for Teaching

Educational implications of the SOLO Taxonomy may be considered under three broad headings: curriculum, evaluation, and teaching method. These headings address questions to do with the content of SOLO items, the use to which the results may be put, and the process by which SOLO is produced and possibly enhanced. The actual implementation of the Taxonomy will involve detailed analyses in terms of the particular subject matter concerned. In this section we are concerned only with general principles which apply to all subjects: details of implementation for particular subjects will be discussed in a later section.

1. Curriculum

The SOLO Taxonomy points to a content analysis at three levels: (i) the curriculum itself; (ii) the particular task or item; and (iii) the setting of instructional objectives.

(i) Curriculum Analysis

Academic subjects are taught with two main effects on the student in mind: the assimilation and understanding of the content of the subject (i.e. the facts and concepts that constitute knowledge of the subject); and the cognitive processes that are induced by a proper understanding and application of the subject (i.e. the skills and strategies that constitute the appropriate way of thinking for that subject). We may thus refer to the content and process aspects of learning a subject matter (Biggs, 1973). Both are addressed in the school curriculum, although traditionally content aspects have been accorded more explicit weight in probably most subjects.

Bruner (1960) strongly emphasized the interplay of content and process features in the overall structure of a subject matter. He spoke of the "generic codes" of a subject. These are the basic process and content structures that make the subject. Understanding or assimilation of these codes however can be partial, and increases from year to year with both experience and cognitive maturity: hence the notion of the "spiral curriculum", according to which a topic is successively re-addressed, at a deeper level of understanding each time.

This is relevant here because the SOLO Taxonomy provides a measure of the quality of assimilation in terms of progressive structural complexity. Ultimately, a true understanding of a subject would involve SOLOs at the extended abstract level in the basic generic codes of the subject. This

is, however, unreal in the high school curriculum for many students. Relational responses might be acceptable from a person who does not intend to continue academic study in depth in a particular area; relational responses would imply an understanding of the basic concepts and their inter-relationship given a particular context. In certain areas, and with some students, it might even be considered adequate if a few basic concepts were understood, without insisting on their inter-relationship. At primary school level it is unrealistic to expect children to achieve anything but partial (and not very high level at that) assimilation of the generic codes of content areas. In most content areas for most students at this level of schooling, multi-structural responses may be considered adequate as these indicate the concrete understanding of a few basic concepts. These are, however, questions for the whole educational community including the curriculum developer to decide: the point is that the SOLO level can be used as at least one important index of structural complexity, and hence as an instrument for operationalizing curricular goals.

The next tasks are to denote both content and process generic codes for the subject in question; and to decide upon a level of outcome that is appropriate to the year group. The analysis into codes obviously requires an intimate knowledge of the subject itself, as well as of the curriculum; a comprehensive assault on the curriculum would probably need to be done by a team, involving the classroom teacher, and a specialist in each of curriculum theory and the discipline concerned. This is not to say, however, that individual teachers cannot usefully employ the Taxonomy in isolated areas if they wish, but that a full-scale analysis would require a range of expertise that is unlikely to be found in any individual teacher.

The kinds of things that would be defined in such a generic code analysis might include:

Mathematics: mathematical operations, variable, systems;
History: sequencing events in time, attributing causes, making value judgments, resolving conflicting reports of an event;
English: understanding and using grammatical constructions, integrating affective and cognitive communication, using metaphor, and so on.
The list is endless. Examples for different subject areas will be discussed in the next Section.

The first-stage analysis, then, picks out crucial areas, both process and content, that are to be covered to a given level of structural complexity. The particular tasks are derived from these areas.

(ii) Task Analysis

The next stage of analysis is to select or devise an item or task that embodies the content or process code in question and then analyze the specific content of that item. This means that one must nominate the features comprising the components or dimensions that enable the distinctions between the various SOLO levels to be made.

The principle of analysis is the same in both content and process tasks. In the simplest content example - let us say a short piece of prose that leads to a question asking the reader to state a conclusion - it is necessary to define the minimal features any one of which could comprise a uni-structural response; and several of which a multi-structural response. Some sort of relating concept then needs to be identified in the passage for a relational response. An extended abstract pro-forma is often unpredictable, since different respondents might construct different hypotheses, but at least it is clear when this does happen. To summarise, then, there are inherent in the data a series of whats that need to be identified; and the teacher has to decide what is a what (for examples turn to Section C).

In process tasks we deal not with bits of content, but with hows, i.e. how did the student go about the task, what skill components did he deploy. For example, word attack skills in reading may be classified as: whole word, phonic, spelling, analogy to known word, etc. A random, unsystematic or incorrect use of any or all of these skills would be pre-structural; consistent use of any one, uni-structural; use of several, multi-structural; systematic choice according to the physical and semantic structure of the word, relational; use of hypotheses based on the context, e.g. possible shades of meaning the author might have intended, in addition to the analysis used at the relational level, extended abstract. In creative writing, the skills would include: events ordered in time, events ordered by logic, competence in the use of vocabulary, competence in the use of structure, change of tense, use of different observer or narrator positions, and so on. Again, the correct use of one skill corresponds to a uni-structural approach (usually this is ordering in time); of several, a multi-structural, and so on.

Thus, where there is a finite task requiring the learner to come to grips comprehensively with it, it may in principle be analyzed in SOLO terms. If the task is content-oriented, the analysis is in conceptual units (the whats) making up the passage; if process-oriented the analysis is in terms of the skills (the hows) that are required. The teacher must

of course be in sufficient mastery of his subject matter to analyse the task in this way.

(iii) Setting Instructional Objectives

A first step towards rationalizing the curriculum is normative; to find out what levels students presently achieve at given age/year levels under existing conditions. This is one prerequisite to determining what are reasonable educational goals. It is, no doubt, what many educators thought they were getting by applying Piaget's theories of cognitive development but as we have seen the uncritical application of Piaget is likely to be misleading. According to the latter we would, for example, expect most children to be well into the formal operational stage in early high school, typically producing extended abstract responses in all subject areas. We know that that is unrealistic. Thus, two main questions remain: what are reasonable levels for children to reach at different ages and in different subject areas; and do ages vary between areas for the same response level?

Work is commencing on answering these questions but clearly proper answers would require a great deal of systematic research, and this has yet to be done. The results would however be important, particularly with the development of school-based curricula, as the results would provide each teacher with a nucleus of tasks and levels of performance quality that would reasonably be expected on those tasks from students in the target year. Nevertheless, as will become clearer in the next Section, the teacher can at any time determine what levels he is typically getting from his class. He can of course use this feedback to adjust his objectives.

In short what is being proposed here is that SOLO levels can be used as the criteria for qualitatively acceptable levels of performance in a criterion-referenced instructional setting. Gray (1978) draws attention to the relevance of Piagetian stage theory to instructional design in the general sense that a good understanding of theory should help the teacher pitch instruction at, but not beyond, the current level at which the child is operating. Gray suggests that the union of criterion-referenced measurement and Piagetian theory could together make this attempt practicable: this is precisely what the SOLO Taxonomy is supposed to do.

In summary, SOLO has three basic implications for general curriculum:

1. The analysis of the broad curriculum itself into generic tasks which are to be understood at certain prescribed levels if the curriculum is

to be held to be taught satisfactorily. This will often involve a value judgment on the part of the educator.

2. Identifying, within the generic tasks, particular tasks that illustrate essential content or processes. Examples are given in the next Section.

3. Using levels, determined either empirically or as a matter of professional judgment, as instructional objectives, set such that not only is the nature of the task predetermined, but also the level of performance quality (metered in terms of SOLO) required for that task.

2. Evaluation

The most ready application of the SOLO Taxonomy as we see it is with respect to evaluation, as of course is implied in its use for setting instructional objectives. Evaluating educational outcomes can be carried out quantitatively or qualitatively. There appears, however, to be an inconsistency between what most educators think is desirable, and what educationists can offer in the way of a suitable technology. Most teachers would probably argue that the quality of learning is of critical importance, but the (in fact quite sophisticated) technology of testing is aimed at evaluating quantitative outcomes.

Quantitative evaluation is concerned with the number of correct responses, the number of points made, the references covered, and so on. It is most obvious in grading by objective tests, according to which the student's performance is assessed simply on the number of correct responses he scores. However, the quantitative philosophy is still equally as powerful, if rather less obvious, in the marking of essays. The almost universal system is to allocate a mark or so for each point made, plus a smaller or a larger loading for "quality" at the end. The determination of that loading for quality is however carried out according to some quite personal and private calculus of the individual teacher; and he might be hard put to explicate, particularly to a student, just what does constitute "quality" in a response.

While it is certainly true, then, that educational measurement has a formidable technology, virtually all of it is concerned with evaluation in the quantitative sense; and most of that is with respect to norm-referenced evaluation, i.e. with obtaining grades that reflect differences between students in the amount they have learned of a subject matter, rather than reflecting the amount any particular student has learned under instruction. Further, most test statistics are based on item analysis and statistical techniques that make assumptions about the normal distribution of scores.

In general, within the mainstream of evaluation technology, there are few specific provisions for qualitative evaluation of student output; a fact supported by the lack of instrumentation designed for this purpose.

This deficiency has of course not been unnoticed. The well-known Bloom Taxonomy (Bloom, Engelhart, Furst, Hill and Krathwohl, 1956) was specifically designed to provide teachers and test constructors with a means of ordering items in terms of hierarchical level of quality. The Bloom Taxonomy outlines six levels of response, ranging from Knowledge (rote reproduction), through Comprehension, Application, Analysis and Snythesis, to Evaluation. This Taxonomy has proven useful but it does contain some difficulties.

First, the Bloom Taxonomy is really intended to guide the selection of items for a test, rather than to evaluate the quality of a student's response to a particular item. In other words, in order to seek adequate coverage, a teacher would set some items at the Knowledge level, some at the Comprehension level, some at the Analysis level, and so forth, thus making sure that a student cannot "get by" by giving just a large number of lower level Knowledge or Comprehension responses. Thus the function of the Bloom Taxonomy is rather different from that envisaged for the SOLO Taxonomy.

Second, and arising out of the first point, it is not always easy or even "natural" to devise items to draw out levels of response much beyond Comprehension (Anderson, 1972). This difficulty reflects the theory behind the taxonomy: it does not, as does the SOLO Taxonomy, imply the psychogenesis of good learning as reflected in the various stages of cognitive development. The student's responses to the Bloom Taxonomy are constrained by the type of item set: SOLO responses are classified after the student has tackled the item. This is not to say of course that the way the item is put does not influence SOLO level to some extent, but in general SOLO is a function of the student's interaction with the item and is not preset by the item. The Bloom levels are <u>a priori</u> ones imposed in advance by the teacher; SOLO levels are those that arise "naturally" in the understanding of the material.

Another, much less well known, evaluation device for assessing quality in written essays is that suggested by Schroder, Driver and Streufert (1967). These writers were interested in "level of conceptual structure" (CL) manifested by an individual in complex situations. CL refers to "the way an individual receives, stores, processes and transmits information" (op. cit., p. 8) and in particular refers to the level of awareness of

oneself as an autonomous choosing agent in a particular situation. These writers stress that the CL manifested will not be a constant property of the individual, but will be determined by his particular knowledge of, and experience in, the situation; and, in this respect, their view of CL is closer to our own view of SOLO than to developmental stage. They distinguish four levels of conceptual structure:

1. Unidimensional, characterised by minimal conflict and rapid closure, and categorical judgment.
2. At least two dimensions are attended to, and this may lead to conflicting and inconsistent judgments.
3. Uses subordinate rules to relate inconsistencies and resolve conflict; more felt choice, less determined by external forces.
4. Theoretically oriented; able to generate own rules to cover all cases, including hypothetical ones.

This classification was intended as a general classification of "levels of information processing" particularly in experimental social psychology. However, in Appendix 2 (op. cit.), the writers show how their scheme may be applied to marking undergraduate essays, particularly where the essay question presents two conflicting or discrepant points of view and the student has to make a judgment, in a context that is unfamiliar to him. The CL scores thus obtained appear to measure something different from objective attainment scores and the writers suggest that, to the extent that the university values structural complexity in handling subject matter, they should be used for grading or selection purposes. However there appear to be no subsequent reports in which the CL scoring instrument has been used by practising educators.

In many respects, the scheme of Schroder et al is similar to our own proposals. Their first level corresponds to uni-structural; their second to a transitional multi-structural (3A); the third to relational and the fourth to extended abstract. Our own scale extends more widely than theirs: five levels and four transitions and - because this is our intention - SOLO is probably more easily applicable to a wider range of educational situations. However the general point of Schroder et al , that low levels of structural complexity in student responses are not incompatible with conventionally "good" marks in the sense of recall of factual detail, is well taken.

Specifically, what is intended with SOLO, then, is that it may be used to make clear to teacher and student at least one aspect of a quality

performance. It is not suggested that SOLO-based gradings should supplant quantitatively based evaluation - it still remains important to know how much a student has learned - but that in addition to indices of how much, we should also have an index of how well integrated is the student's learning.

Finally, and most recently, Marton and his colleagues at the University of Gothenburg (Marton, 1976; Marton & Saljö, 1976) have approached the study of student learning from a phenomenological standpoint; that what a student learns can only be gauged from the student's own perspective. This viewpoint has the further corollary, Marton believes, that learning can only be evaluated in terms of the content of the learning. A learning "process", over and above the content learned, might be a useful abstraction for psychologists to use, but it has nothing to do with assessing a particular interaction, here-and-now, between a student and the content he is studying.

This conception led Marton to assess learning in terms of what the student said he got out of a particular learning episode (e.g. reading a short passage, or answering a question that poses a problem requiring specific knowledge for its solution). In general, he found that students' responses could be classified into four levels, each level showing increasing grasp of the complexities of the material (see Marton & Saljö, op. cit.). Surprisingly, these levels were virtually identical to the first four SOLO levels (Biggs, 1979a).

There is then some agreement, with what previous work there is, that:
(a) qualitative assessments of student learning are desirable and necessary;
(b) such assessments may be made in terms of the structural complexity of the outcome;
(c) the levels are ordered in terms of characteristics that include progression from concrete to abstract; an increasing number of organising dimensions; increasing consistency; slower closure; increasing use of organising or relating principles; with hypothetical or self-generated principles being used at the most complex end.

Such a scheme seems to meet the desiderata mentioned by Gray for combining the Piagetian stages with the principles of criterion-referenced evaluation (see above; Gray, 1978). While previously, criterion-referenced evaluation has been used only quantitatively, e.g. as in 90-90 criteria for mastery learning (Bloom, Hastings & Madaus, 1971), SOLO analyses of the tasks can be used to define criteria that are based on a qualitative view of mastery.

Thus if a student fails to meet the prescribed SOLO levels in a task, the nature of his failure will provide some clue as to the problem; in other words, the SOLO task provides formative feedback to the teacher. For example, a student might consistently fasten onto the first, or the most striking, concept in the text and close on that, not seeing there are many other relevant concepts there too. The teacher would then need to remedy this, by drawing the student's attention to other aspects, and easing pressures to respond quickly.

In addition, SOLO analysis provides the teacher with a structure and a vocabulary, which he can use to explain to the student why his essay, for example, receives only a "C" instead of an "A" or "B". One student, for example, might question why he received "C" while another student received "B": "I had the same points noted down as Tom had!" If Tom was responding at a relational level, then it can be explained that yes, he did have similar points but they were linked up into a whole. Meantime, Tom's "B" can be explained in contrast to Fran's "A" on the grounds that Fran had introduced logical possibilities into her argument and Tom has stuck to the given context. The teacher's marking scheme thus has an objective justification, and can become involved in the teaching process as well as being an evaluational tool.

3. Teaching Method

There are several aspects to teaching method suggested by SOLO, some of which have been already indicated.

(a) Adjusting Exposition to the Level of the Student

It is common for teaching level to be pitched around the middle of the class, with the attendant risk that brighter students may be bored, and duller students lost. There are many reasons for this state of affairs, including administrative ones. But even if teachers were able to deal with students on a small group basis, how would they know at what level they should pitch their teaching?

SOLO analysis can help. We are a long way from teacher-pupil interaction studies to give us precise guidelines, but at least the structure described gives the teacher a technique whereby he can make a professional judgment as to whether to attempt to raise the level of response or accept the level given. If he selects the former procedure then he must decide on the means to this end. Should it be more questions asked immediately or would it be of more benefit to the learner to delay further consideration of the problem until more concrete experience is given in the area

concerned? Perhaps a procedure, consonant with work in related fields (e.g. Rest, Turiel, Kohlberg, 1969, in the field of moral education) the "Plus One" strategy would be appropriate. Using this technique the teacher provides information and feedback that is structured up to (but not beyond) one level higher than the student's present performance. If it is pitched at the same level, or lower, then the student isn't learning to handle a more complex structure, and if it is higher than one level, the student may not be able to comprehend the point being made.

This usage refers to the formal matter of whole class presentation, but the same principles apply to more informal areas of teacher-student interaction; for example, individual question-answer during the lesson, or in commenting on an individual student's submitted written work.

The point gains force if we consult Table 1 again (see especially column 4). The different levels of SOLO are cumulative: each one adds something to the previous one. A uni-structural response is a pre-structural response plus a logical link between cue and response; a multi-structural response is a uni-structural plus at least one other relevant aspect; a relational response is a multi-structural one plus an over-riding linking concept; an extended abstract response is a relational plus a super-ordinate logical principle. In other words, in reaching a particular level, all preceding levels are implied. Of course, there might well be intrinsic or internal reasons why "Plus One" will not work; the student might already be "working to capacity" or "have reached academic ceiling", and in that case the correct instructional strategy is not to aim vertically but horizontally, i.e. to provide more varied enrichment experience at the same level. The optimal instructional strategy might therefore be to try the "Plus One" or vertical strategy first. If a student clearly cannot understand why a relational type of response is superior to his submitted multi-structural response, then he evidently needs more experiences and enrichment generally at the multi-structural level itself.

An issue which does not emerge so clearly from the present theory, but which is nevertheless related to the present discussion, is the value of the instructional strategy of teaching from the concrete to the abstract. A uni-structural response is more "concrete" than a relational one in that the latter is dealing with relations between concepts: the former is "concrete" in the sense of being simpler, easier to handle. Clearly, in this sense of concrete, it is almost a requirement that one must pass through lower levels to reach higher ones.

The other meaning of "concrete" is tangible, non-abstract, within immediate experience. Piaget himself certainly stresses this meaning of concrete when he talks about logical operations arising out of actions the child carries out himself (as opposed to being told about them). Unlike Piaget's theory, SOLO is a scheme for analysing responses; it is not a theory of how concepts are formed. Consequently SOLO doesn't say much about the medium by which pre-structural responses become transformed into uni-structural responses; for that one would have to go back to the parent theory, and the implications from Piaget, for example, are very strong that adequate formation of concepts up to the relational level would require direct experience. This would apply when a new area is being tackled; indeed it would especially apply in that case. Because someone typically responds in an extended abstract way in science or mathematics does not mean that the individual will handle history at an extended abstract level. He is more likely to "get the feel of it" (as a new subject) by playing with isolated concepts at a multi-structural level, rather than by an abstract lecture.

(b) Improving SOLO Levels

In this section we refer to the possibility of facilitating the process of obtaining high level SOLOs. Sufficient work has been done in this area (summarized in Biggs, 1979b, 1979c) to make some generalizations about the conditions under which high level SOLOs are produced.

These factors or conditions can be classified into ones that are psychological (i.e. "inside" the student) and situational ("outside" the student). Psychological factors influencing SOLO include the existing stage of cognitive development of the individual (See Section A, Table 1), which it is suggested places the upper limit on the student's SOLO level. If he is at the middle concrete stage, in other words, it is unlikely that he will give relational or extended abstract responses in any subject. However, since the teacher is unlikely to know what stage any particular student is at (apart from making very rough estimates from chronological age), this problem is more apparent than real. If a student is currently responding at a multi-structural level, then according to the "Plus One" strategy, the teacher would encourage him to respond at the relational level but not beyond that. In short, the teacher might profitably forget about stages of cognitive development and concentrate instead on the psychological or internal factors over which he may have some influence. Such factors include the student's present motivational and emotional state; study processes; reading ability (when that itself is not the

target of a SOLO analysis); and most importantly, prior knowledge of basic relevant concepts and familiarity with the particular task.

Situational factors refer to the conditions under which the task is presented, and variations in these conditions, e.g. the wording of the main question, can alter the outcome considerably. Such situational factors include the concreteness of the task; the nature of the task requirements (does the student really know what he is expected to do; or does the question asked imply low level responses?); the time available on the task; the effectiveness of prior relevant teaching; whether the teaching environment is relaxed or stressful; and so forth.

Let us now take some of the more important of these points:

(1) Student's Prior Knowledge

The most dramatic improvements can be obtained if it turns out that the students were missing some crucial information (e.g. a relating concept that could do the trick in producing a relational response). In fact, the SOLO Taxonomy is defined as instruction-dependent (unlike IQ or Piaget's tasks, which are deliberately designed to minimise the effects of instruction and maximise those due to psychological factors). Clearly, if the student has no background in a subject he cannot bring to bear the concepts, skills and discriminations necessary for the higher level responses.

In the section on curriculum, above, it was suggested that ideally the curriculum in a subject could be analyzed into its generic codes, and that in the course of schooling a "spiral" approach to the curriculum could be utilized: this year's multi-structural response becomes next year's relational goal, on a generic task. This approach of course relies heavily on the successive organization and integration of prior learning. Things will be less structured than this in most schools, but the general point remains: prior knowledge is crucial.

(2) Use of Concrete rather than Abstract-verbal Teaching Media

It was suggested in the preceding discussion that concrete embodiment of a test item is likely to result in a higher level of responding, even though the logical structure is the same. For example, the following mathematics problem is instantly solvable (as opposed to laborious working out in full) at the concrete generalization stage of development (i.e. associated with a relational response): does $\frac{3 \times 5}{3 \times 5} = \frac{3 \times 598}{4 \times 598}$? However, it is not until the next stage of development that the student can handle the implicit logical structure involved as expressed by the general statement that for all values of n, m, a and b, $\frac{n \cdot a}{n \cdot b} = \frac{m \cdot a}{m \cdot b}$ (given the

required definitions). Dahlgren,* a Swedish psychologist, found that a group of primary school children performed very badly on an item that asked "Why does a bun cost one kroner?" with virtually no students giving anything better than what we would call a pre-structural response in Grades 1 and 2. However, when they were asked "Why does a bicycle cost more than a bun?" about 30% of these children gave uni-structural and multi-structural responses. The first question, although logically the same as the second one, required a fairly sophisticated understanding of the money system in order to give an adequate reply, whereas the second question asked about objects directly within the child's own experience. Clearly, the sort of question one asks needs to be very carefully considered.

(3) Familiarity with task details and specifications

Expectations of high level responses are unwarranted unless the individual has had very considerable experience in the field. This point was made in Section A, in which it was stated (footnote, p.15) that experience automated or "contracted" the unit or element in working memory. With experience, and high familiarity with the elements of the task, then, more space becomes available for higher level responses. Experience is then a necessary but not a sufficient condition of high level SOLOs. Thus, we see that even highly skilled professionals who are accustomed to giving elaborate extended abstract responses to questions in their areas of expertise will need a certain amount of concrete experience in an unrelated field before they can lift their responses above the relational or even multi-structural level. For example an historian discussing a psychological problem with a psychologist might well ask for a number of "for instances (concrete examples)" when presented with any diagnosis involving an abstract psychological concept. Thus, it is to be expected that a student will respond at a lower level if he is presented with a new or unfamiliar item-type. One aspect of this latter phenomenon is included in what psychologists refer to as "test wiseness", which implies that if a person's optimum performance is to be assessed, he needs to have plenty of practice and experience with the particular test being used to make the assessment. Analogous examples from everyday life are easily found. For instance, experienced drivers feel unsure, and tend to make mistakes, when driving an unfamiliar make of car for the first time: their real skill is manifest only after they have become familiar with the new vehicle.

(4) Nature of the Task

The nature of the task itself can affect level of response. Some tasks are inherently more difficult than others; for example we found that

* Private communication.

interpreting cartoons was far more difficult than interpreting documentary material (letters) referring to the same historical period.

The point was made earlier that one of the uses of the SOLO technique was to facilitate the analysis of the task dimensions. Two tasks which look exactly the same (on the surface at least) to the adult experienced eye may represent enormously different levels of difficulty to the inexperienced neophyte - examples abound in classroom type activities. The cartoon example just given is one. Another from elementary mathematics follows. Because a child has the ability to understand and work meaningfully with two small numbers and one operation, e.g. 4 + 1 = 5, it does not follow that he is able to understand and work meaningfully with two large numbers and one operation, e.g. 278 + 396.

Personal preference for particular kinds of task also seems to play a role here. Some individuals seem to develop, for whatever reason, a strong liking for a particular activity and because they are highly motivated will spend a lot of time and effort in working in the area. When the task is presented meaningfully, Biggs (1979c) found that higher level SOLOs are produced than when students are instructed to attend to facts and details; students who tend to avoid rote learning as a general strategy of study, however, can use factual detail to construct high level SOLOs. Again, what matters is how the student construes his task.

(5) Time on Task

Time pressures could lower levels of responding. One problem here is that, for administrative rather than educational reasons, instruction proceeds in fixed time slots and so it is possible that only the bright children always have adequate time to complete a task. It is likely that increased level of responding to an item could be brought about simply by providing more time - perhaps particularly more perceived time - so that students don't feel they have to rush their responses. The notion of time is involved in the process of responding in the concept of closure: rapid closure involves selecting only one or a few features before coming to a decision, hence a low level of response. High levels are not possible without careful consideration of all the data. Thus in the case of the sophisticated adult the time taken to achieve a high level response will be longer than that taken to come to a "snap" low level decision. However, if we consider students responding at their optimum level there seems to be no reason why this should be so since the required increase in the amount of data to be considered by the high level reasoner is compensated for by the more sophisticated level of the skills employed.

(6) Effect of Emotional Interference and Motivation on Response Levels

The literature makes it clear that an individual's emotional state has a direct effect on the efficiency of his cognitive functioning. Thus a student who is responding to an item when he is under extreme stress (for whatever reason) will do poorly: stress causes both rapid closure and distraction from the task itself. It is important to distinguish between stress and motivation. The problem is that the same condition - for example, standing up in class and responding publicly - might provide the right level of stimulus to some children, but provoke breakdown in others. The teacher's task is to discover the right level of pressure for each student, i.e. when he is motivated, without feeling under sufficient stress to inhibit his optimal level of functioning.

This ability to exert the right amount of pressure is a crucial professional skill for the teacher and a very difficult one to acquire. The skill is crucial because one of the reasons for low level responses is that the individual does not see the necessity for or even feel like exerting himself to provide a higher level response - there is no reason for the usual assumption behind testing techniques that the children (or adults) will automatically and always respond at their best level. The skill is difficult to acquire and to apply because the optimum amount of pressure will vary not only from individual to individual but also for the same individual on different occasions depending on his emotional state or even the content area.

There are, then, several things the teacher can do to maximize upper level responses, from setting a target just higher than the student's present level of responding (the Plus One strategy), to manipulating the conditions under which the task is administered.

Summary of General Implications

Whatever the subject area, the SOLO Taxonomy can impinge on teaching in the three main areas of curriculum, evaluation and teaching method.

1. Curriculum

(a) Task analyses:

(i) of curriculum, to establish the generic codes for each subject in both content and process domains.

(ii) of generic tasks or items to establish the features or aspects of the task (the whats or hows) that constitute adequate responding.

(b) Setting realistic objectives within each subject and year.

(c) The establishment of norms for each subject in different years of primary and secondary schooling.

2. Evaluation

SOLO is essentially concerned with evaluation. Although it may be used in the traditional norm-referenced model, it is especially useful in a criterion-referenced model:

(i) SOLO levels can be used to set the level of mastery required, and

(ii) the model provides formative feedback - a structure and a vocabulary - that teachers may use for further instruction.

3. Teaching Method

The process of SOLO production suggests several implications for teaching method:

(a) Adjusting the level of exposition by the "Plus One" strategy, in both formal and informal classroom interaction.

(b) Improving SOLO levels by:

  (i) Monitoring students' prior knowledge;

  (ii) Use of concrete rather than abstract testing media;

  (iii) Maximizing familiarity with task details and specifications;

  (iv) Selecting appropriate tasks;

  (v) Allowing sufficient time on task;

  (vi) Maintaining adequate motivation but not to the point of excessive stress.

These points are ones suggested by previous research and by conceptual analysis of the nature of teaching. It now remains to apply these principles to particular teaching subjects.

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SECTION C

EXAMPLES OF THE TAXONOMY IN USE

1. HISTORY

Section C: Examples of the Taxonomy in Use

1. History

Before discussing implications for teaching, some illustrations of the various levels of the SOLO Taxonomy are presented. There are many kinds of item which elicit classifiable responses; each item-type or situation has its own purpose within the history curriculum. For illustrative purposes, the following situations will be used in this Section:

(1) Drawing conclusions from a display of information; e.g. a lesson, an original document.
(2) Making value judgments about an historical event.
(3) Reconciling conflicting evidence from different sources.
(4) Constructing a plausible interpretation from incomplete evidence.
(5) Understanding historical terms and social concepts.
(6) Inducing the meaning of a concept from a context.

Many other situations could be used, and the broader question of the relative value of situations and item-types, and their place in the structure of the discipline of history as taught in schools, will be addressed later in this Section.

(1) Drawing Conclusions from a Display of Information

(a) A Lesson on the Role of Squatters

After a unit of work, including a debate, on squatters in Australia the students (Year 9, average to above average ability) were asked: "What reasons did the squatters have for defying the government's regulations? Were they justified?"

Examples of Responses

1. Pre-structural

"None. They defied the government."

"They were justified, but many of the squatters were quite wealthy anyway."

The first student has simply repeated the question: his response is tautological.

The second student has come to a firm conclusion (closure) but has supported it with an irrelevant piece of evidence based on transduction.

2. Uni-structural

"Yes, because they were helping to develop the wool industry."

The student has chosen a point of view (i.e. has closed) using only one piece of evidence to support his decision.

3. Multi-structural

"Yes, the squatters were justified because there was better pasture land outside the limits of location and another reason was that the wool industry would grow."

This student has also chosen a closed result, using two items of information from the material presented in class to support his decision. However, the items are unrelated to each other.

4. Relational

"No. I don't think the squatters were justified because although the price of land was too high and they did not have enough security and it was wrong to go and just take over the land without permission; laws are made to be kept by the public."

This student has presented some points for both sides, and has used the relating concept of law and order to give a closed answer. He has the ability to generalize but his willingness to do so has caused him to lose sight of a very important aspect of the situation - the squatters partly chose their course of action to put pressure on the government to alter the law.

5. Extended Abstract

"It depends on how wide a term you want 'justified' to be. In a restricted sense you could say that the squatters were not justified because the Government saw a need to develop and focus its resources in a known rather than an unknown area. If you widen the term, you can say that the squatters felt themselves to be justified, since they had emigrated largely so that they could own land. When they arrived they found that the land was too expensive so they "squatted" on it and by hard work and occupancy, felt they had made the land their own. Taking an even wider view the squatters were justified because in the long term, the wealth of the Australian colonies rested on the productivity of the squatters."

This student holds the question open and within his defined frame of reference he presents a reasoned argument combining the variables of the situation to form a comprehensive judgment. He is able to free his thinking from his own experience to consider the personal situation of the squatters - "they felt themselves to be justified since ...". He has used the class material but in such a way as to place his response in an abstract conceptual structure.

(b) Letter from a Convict

The following item was given to Year 11 and Year 12 students:

"Read the following letter and then attempt the question below:

Experiences of a Convict, 1835

Dear Mother and Father,

This comes with my kind love to you, hoping to find you in good health as, thank God, it leaves me at present very comfortable indeed. I have a place at a farm-house, and I have got a good master. I works the same as I were at home, I have plenty to eat and drink, thank God for it. I am allowed two ounces of tea, one pound of sugar, 12 pounds of meat, 10 pounds and a half of flour, two ounces of tobacco, the week, three pairs of shoes, two suits of clothes, four shirts, a year; that is the allowance from the Government. But we have as much to eat as we like, as some masters are a great deal better than others. All a man has got to mind is to keep a still tongue in his head, and do his master's duty, and then he is looked upon as if he were at home; but if he don't he may as well be hung at once, for they would take you to the magistrates and get 100 of lashes, and then be sent to a place called Port Arthur to work in irons for two or three years, and then he is disliked by everyone.

From

your loving son

Question: How difficult was a convict's lot?"

Examples of Responses

1. Pre-structural

(a) "Very difficult."

(b) "The convict had a fairly difficult time."

In none of these responses has the student made any real attempt to give a structured response containing evidence.

1A. Responses were not observed in this sample.

2. Uni-structural

(a) "Some convicts had a hard time while others who did as they were told seemed well off."

(b) "A convict's lot was not difficult if he was well behaved, however, if he was of bad behaviour he would be punished."

Both of these responses basically make a single point which appears in the original letter.

2A. (a) "If a convict had a reasonably good job and master, the main thing a convict had to do to have a reasonable time was to keep his mouth shut. Though I think the conditions were a little difficult considering most crimes they were sent out for were only petty crimes."

(b) "It was not difficult because they had food and shelter and they were better off there than at home. But if they played up they would be hung or have 100 lashes or be sent to Port Arthur."

Response (a) has one major feature ("keep his mouth shut"); then he brings in a major qualification, so that the conclusion is that conditions were a "little difficult", instead of "reasonable". It is hard to see what this student really thinks on the argument presented.

Response (b) states a conclusion and one main supporting feature. However the student then adds an observation that is totally inconsistent with the conclusion (it is also incorrect on the matter of hanging) but does not modify the conclusion.

3. Multi-structural

(a) "The letter in itself explains or answers that question. The convict's lot could be made difficult or not, depending upon the behaviour of the convict himself. If he worked well for his master, he lived well without much complaint. However, if the convict's conduct was found to be improper then he was accordingly punished. The answer is easily obtainable in the last six lines of the letter."

(b) "From the impression I have received of a convict's lot I would say that the convict in the above passage was a lucky one. I don't believe that convicts had a very good life at all. They were convicted for stupid reasons (e.g. stealing a loaf of bread) and shipped to Australia to begin life again in a new but harsh country. In their new life they were confined by chains. They were chained together at the ankles and in this way were supposed to split rocks, build huts etc. They were shipped for misbehaviour, were fed scraps etc. If they were extremely good they were given to wealthy land-owners and depending on the kindness of their masters they were treated accordingly. Many were eventually freed and began another new life, but for most it was a hard life."

This item elicited more Level 3 responses than any other kind; perhaps because by quoting a few key sentences directly from the letter a reasonable clear picture of the respondent's view of the convict's life could be obtained. Response (a) points out precisely this; while response (b) draws on other information that makes the same point. Each of these responses refers directly to concrete conditions as they were reported to exist, with little inference or argument.

3A. "If they did what they were told and never stepped out of line the convict's life was not too difficult. Their masters seemed fairly generous in the goods available to their convicts and as long as they were obedient and kept quiet they were well looked after and treated reasonably well. But sometimes it is difficult to obey and apparently the penalty for disobedience was transferring to Port Arthur and severe punishment.

Once under these conditions the life of a convict was more pitiful and difficult. Unfortunately through this letter it seemed that the son was either a very early age or severely lacking in education due to the comprehensive ability. Nevertheless schooling was very hard for convicts and it would probably be unwise for schooling as they would learn to speak up more and punishment would have been more succeptable. It would have been a lonely and unreasonable life for a youngster or for any aged convict but it was up to them if they were well treated whether or not they were obedient and fond of their masters.

Therefore a convict's life would have been difficult if in the way they always had to do what they were told and never revolt or else the punishment would be so serious it wouldn't be worth living as stated in the letter."

This student has summarized two fairly cogent arguments, but for opposing conclusions: it is a relational response without the relating concept. Hence it is hard to know what the student's final interpretation really is.

4. Relational

(a) "This convict seems to have a fairly good life, but does point out that he is one of the lucky ones and realizes there are many less fortunate than himself. The allowances seem small to us, but he seems to be quite satisfied by them. He realizes his "place" in the household and respects his master's position and his insistence on good behaviour."

(b) "I have relatively little knowledge about Australia's early colonial years but the convict, who wrote the letter, doesn't seem too unhappy. His lot wasn't too difficult considering the clothes and food he was provided with. I believe his lot was far worse from the psychological point of view: he has to keep 'a still tongue in his head', the convict could be compared to a dog obediently following his master. The punishment received for objecting, 100 lashes, is severe as well as expulsion from society '... and then he is disliked by everyone ...'"

(c) "The convict lead a rather comfortable life, since he received good food, a home, and various clothing. Their only complaint could be that they could not voice an opposing opinion. That is not a particularly heavy price to pay, considering the benefits given. The convict was probably happier and better off in Australia than his poverty-stricken country, England. The name 'convict' should be changed to 'worker', since he acts exactly the same as workers do today."

The relating concept in (a) is the recognition that some convicts were in a good situation and others were not: this is expressed from the point of view of the convict and gives balance to the conclusion. In (b) a similar point is taken by the writer, that whereas in physical terms he seemed well off, psychologically he was not. (c) has a relational structure

in which the student has tried to weigh up the cost-benefits in terms of his comparative well being. The last sentence is interesting; if the writer had developed this point, the response could become at least 4A and arguably 5 since the notion of selling subservience for material gain subsumes both convict and worker.

4A. (a) "In a word the life of the convict was 'lousy' depending generally as is implied above as to the master in charge, soldier in charge. 'For the Term of His Natural Life' depicts a more unfortunate prisoner than 'your loving son'. The convict was deprived of personal dignity. The journey to Australia was appalling - they were herded together on a boat like cattle for weeks - the air was foul, many died. The lot of the convict was not much different to the lot of Ivan Denisovitch except that the convicts were never so cold."

(b) "In this extract the life of a convict seems comfortable and pleasant as long as he is a dutiful servant and if he is lashed it is for his own impertinence. However, it must be remembered this is one account of one individual and obviously some views are going to differ vastly to this."

The first response (a) could possibly be categorised as a Level 5 in that the student has made comparisons not only with the classical account of the convict's situation ("For the term ...") but with a corresponding Russian example with the deprivation of personal dignity being the common ingredient rather than that of physical hardship. (b) is rather a low level response in many ways, but it does reach towards the extended abstract structure by reminding us of the relativity of the perspective.

5. Extended Abstract

None observed for this item.

(2) Making Value Judgments about an Historical Event

Value judgments, or moral judgments, are sometimes required in the evaluation of an historical event. The following example has been adapted from Hallam (1967), which illustrates this point. The examples used were obtained from secondary students (12 to 16 years) in response to the following passage.

"The Norman Conquest of England

In 1066 William of Normandy defeated the Anglo-Saxons at the Battle of Hastings. A Norman soldier wrote: 'It would have been just as if wolves and vultures had devoured the flesh of these English ...' But such a fate seemed cruel to the duke and he allowed all who wished to do so to collect the bodies for burial.

The Normans soon conquered the rest of England but in 1069 the English in the North obtained help from the Danes. The Danes sailed up the Humber with 240 ships. York was captured and its Norman garrison killed. The Danes then returned to Denmark so William was able to reconquer the North of England. He carried out a terrible revenge upon the English. Many houses and cottages were burnt; the animals were killed or driven away; most of the people, perhaps the more fortunate were killed; some fled to other parts of England but of those that remained the greater part died of famine. A man who lived at that time wrote: 'men, women and children died of hunger: they laid them down and died in the roads and fields; and there was no man to bury them ...' Between York and Durham every town stood empty, and in their streets lurked only robbers and wild beasts."

Question: Do you think William was cruel?

Examples of Responses

1. Pre-structural

(a) "Yes, he shouldn't have killed them."

(b) "Yes, you shouldn't be cruel."

The first student has centred on one emotional aspect of the passage, and has failed to relate the question to the material presented. The second response is tautological.

2. Uni-structural

(a) "I think William was cruel because it says that men, women and children died everywhere."

(b) "I think William was cruel because it said that he carried out a terrible revenge."

(c) "No, he wasn't cruel really because he did let them bury the dead people."

In each of these responses the student chooses a point of view (i.e. requires closure) on the basis of a single reason which is the dominating evidence to the student.

3. Multi-structural

(a) "Yes, I think William was cruel because it says he carried out a terrible revenge, burning the houses and killing the people and the animals."

(b) "Most of them were only innocent people and there was no need to burn everything."

In these responses, the students chose a point of view (a closed result) using a number of facts from the passage to support their judgment.

4. Relational

"William was cruel because he destroyed the land and caused a famine but the English and the Danes had destroyed his garrison. He also allowed the people to collect the bodies of the people they wanted to buy." (What does this prove then?) "He could be cruel in winning a battle but after the battle was over he could allow the people a little more scope."

This response illustrates well that even though the student is capable of giving two sides of the question, he still requires closure. It is a qualified closure which relates the inherent conflict (cruelty relative to battle). However, he has confined himself specifically to the data; he cannot go outside it to suggest, for example, that it depends on what is meant by cruel.

5. Extended Abstract

> "It depends on what you call cruel. If the definition of 'cruel' is to kill and ravage and burn for any purpose whatever, William was cruel. On the other hand, if one is prepared to accept political necessity, William's cruelty was justified. Compared with many other feudal lords he was essentially a kind man. They ravaged generally for their own advantage and without care for the common folk or their land. Duke William, if the common people went with him, seems to have been prepared to protect the common people from ravages. If, however, they went against them he seems to have treated it as a deliberate breaking of faith and acted accordingly. So, by the standards of his own day, for we cannot really judge him by our standards, he was probably not a cruel man."

This student has given a well structured reply. He has started with an hypothesis, considered the possible evidence, perceived the links between what may initially seem to be conflicting evidence, and provided information from outside the data before drawing a qualified conclusion. He has held the question open while considering the evidence; in contrast to a student operating at lower levels, he does not need to make an immediate closure.

(3) Reconciling Conflicting Evidence from Different Sources

Frequently an historian needs to decide between two conflicting sources of data. The manner in which the conflict is resolved is crucial for determining SOLO level. Such resolution may be achieved by:

1. Pre-structural: avoiding the question (denial); repeating the question (tautology); a firm closure based on transduction.

2. Uni-structural: selecting only one relevant datum.

2A: selecting two data but which are inconsistent, and no conclusion is reached.

3. Multi-structural: selecting several consistent data, ignoring or discounting the evidence that is inconsistent with the conclusion.

3A: recognizing the inconsistent evidence or data but being unable to resolve them.

4. Relational: accepting most or all of the given evidence, and using a given or implied relationship to reconcile the conflict.

4A: a hint that closure is not inevitable; that the relating principle might itself be relative to context, but this is not spelled out.

5. Extended Abstract: reconciliation of conflict by appeal to more universal principles; appeal to data and to principles that are not given; conclusion usually held open.

Year 11 and 12 students completed the following item:

"Below are two views of the conditions in Britain in the 1830's. Read them both and then answer the question.

1. The working classes in Britain, though they have their grievances and distresses are, on the whole, better off as to physical comforts than any other European working class. They have a more plentiful supply of food, better clothing, and better furniture and for this reason suffering is more acutely felt. Yet we firmly believe that, in spite of heavy taxation, a war, and a huge public debt, the country is becoming richer and richer.

2. Factory workers are working from 3.00 a.m. until 10.00 p.m. for three shillings and seven pence halfpenny, a quarter of which they lose if they arrive five minutes late for work. Children of six years old are working in these factories under the most atrocious conditions. The overlookers often beat their workers but no compensation is paid for injuries received at work.
The workers' houses consist of one room with an earthern floor. These houses are packed tightly together around the factory and this together with the lack of proper sanitation make for very unhealthy, in fact, dangerous conditions."

Question: Do you think the British worker was well off?

Examples of Responses

1. Pre-structural

"No."

"Of course not. In that time it was the highlight time of capitalism in England."

The second response is an emotional irrelevancy: the respondent (who was a mature student with a "political" background) might have had a point if he had elaborated but he has merely used a slogan, not an argument.

2. Uni-structural

(a) "The British worker was not well off because of their appalling working and living conditions."

(b) "In comparison to the workers across Europe they were well off. I would not like to see the conditions across Europe."

In each of these passages, the students have responded to only one feature: appalling working and living conditions (these are seen as one total aspect of life rather than as two separate aspects), and comparison with European conditions.

2A. (a) "I don't know. The two articles contradict each other. One describes the working class to be better off and the other seems to issue complaints. 'Day in the Life' of a factory worker, their unhealthy living conditions etc. The British worker depending on what job he actually did could accurately describe his working conditions."

(b) "If the workers in Britain are much better off than in any other country then they must be quite well off, but working so hard and in such terrible conditions not many people would want to do this (the two passages are contradicting this but are showing different points of view), but I must say that not many people would stay healthy in those kinds of conditions these days."

In both the above passages the students have gone beyond a naive unidimensional interpretation: they recognize the conflict but are unable to reconcile the opposing points of view and thus fail to come to any general conclusion.

3. Multi-structural

(a) "I think the average worker was not well off as they worked over 12 hours a day and they would have less time to sleep as they worked the long hours. Their pay was not the best considering how long they had to work. The country may have been becoming richer but the struggle to get there was very hard and tiring."

(b) "No, the British worker was not well off. Although the British workers' conditions may have been better than that of other European workers, this does not prove he was well off. Factory conditions were very bad with long hours and poor wages. The employment of six year old children was outrageous, but of course cheaper, hence decreasing the number of jobs available to the adult worker. This lead to unemployment. The British workers survived in cramped, overcrowded, insanitary conditions; he lived no comfortable life."

In these responses the possibility of an alternative view is not really entertained, and only the evidence for the conclusion is presented. In the second example this "evidence" includes a point, "unemployment", that was in fact not made in the text, but this in itself does not justify an extended abstract classification because the imported term is not deduced from wider principles but is simply a reasonable association (particularly salient at the time of writing).

3A. "No, I do not. The first article would indicate that they were fairly well off and this is the reason that they felt small sufferings. However the evidence of the second passage indicates the traumas that the average worker at this time faced. It could not be true that these conditions could be good, or that this could be well off."

3A responses were rare; the above being the only possible example. The student has a firm conclusion, recognizes the contrary case, but

dismisses it rather than counteracts it as would have been done in a 4 response. However, there are hints here of relational thinking, even of extended abstract (the last sentence is hinting at a definition of "well off"), but these are not developed.

4. Relational

(a) "No, I think their conditions were degrading and appalling. If the British were better off than the Europeans I would have hated to see the Europeans. The first article seems to give an unrealistic propagandistic statement concealing the true facts. 'In spite of taxation, a war, a huge public debt, the country is becoming richer and richer.' - may be the rich are getting richer but the poor weren't. The first article compares the conditions to an indefinite quantity (that is, the European working class) whereas the second gives the true sounding (at least) facts."

(b) "No, the first one contradicts the second one. The first one seems to have been written by someone in government or who owns a factory and has to pay the workers. He is therefore trying to convince himself and therefore others that the working conditions are reasonable. The second and third paragraphs, however, tell quite a different story; the people have to struggle hard to earn their wages."

In both the above responses, a student has attempted to come to a definite but balanced conclusion by appealing to an explanation that reconciles all the data. The explanation is not however in terms of an abstract principle that might point to the relativity of the data.

4A. (a) "Compared to modern day conditions the British worker did not appear to be well off. Maybe at the time British conditions were superior to those in Europe but even regarding this the living conditions were pitiful. With child labour also common practice and heavy penalties for misdoings life would have been unrewarding. The two passages are very contradictory and it is hard to gain a full impression."

(b) "I think that the British workers had to go through some suffering to eventually show improvement. The fact that whether the second view of conditions was the worst ever written on the conditions of the British working class during the time. Maybe there were only one or two factories where conditions were such, or maybe factories everywhere suffered these conditions."

In response (a) the student appears to have come to a considered but firm 4-type conclusion - but then she notes the contradiction and hedges her bets but without attempting to appeal to a principle to reconcile the contradiction. In response (b) the student has raised a very important point, not given in the data themselves, about the generality of the points made: hence she is not able to come to firm closure. This response is arguably extended abstract, but is classified as 4A because it lacks a clear appeal to principle.

5. Extended Abstract

(a) "No, the British worker was not well off. Conditions may have been better for the country than they were once, but they were still not of a satisfactory standard as far as human conditions are concerned. The country was being made richer at the expense of human suffering. The first view gives the impression that working class should be happy because their conditions were better than the average Europeans but using comparisons often gives a distorted view: A man dying of cancer is by comparison better than one dead I suppose; but his condition leaves much to be desired! The suggestion that the English working man suffers more because he is better off is also wrong. Wanting improved conditions was a sign that the English worker was on step 1 to achieving them. The people had to realise their need first. This awareness of their poor life was a good sign.

The difference between the two views is probably due to the writer's position. One was most likely a judge or high-class person, the other someone in direct contact with the worker, someone who could see the worker was not well off."

(b) "No, I don't feel the British worker was well off. I am a student in the 1970's, living in a technologically advanced age and I feel through my studies of History that these people were extremely ill-treated. I conclude this through my emotions and comparison of then to now. The children were given no chance of education, they suffered bodily harm. If the question stated whether the British workers were better off than the Europeans then maybe my answer would be yes. But the question merely states were the British workers well off, and I feel there is no other answer than no."

In response (a) the student accounts for the contradictions and his conclusions in terms of super-ordinate principles that are not given in the data. "The country was being made richer at the expense of human suffering"; "using comparisons often gives a distorted view"; the analogy following (which admittedly is not very good) and the reference to "the writer's position".

Several points should be noted about response (b):

(i) Despite the admission of emotion, this student is very "cool": she stands apart from her judgment and can admit the emotion and explain its source.

(ii) Likewise, she is aware of her perspective: she is making a detached (although deeply felt) judgment across time and culture.

(iii) Her closure is relative to the question; she can admit a different closure to a different question and entertain the possibility that other questions could have been asked.

(4) Constructing a Plausible Interpretation from Incomplete Data

The study of ancient history in particular often requires an interpretation of a display, when some crucial evidence is missing. Two examples are given below.

(a) The Function of Stonehenge

Lodwick (reported in Peel, 1959) presented children aged 7½ to 15 years with the following:

> "Stonehenge is in the South of England, on the flat plain of Salisbury. There is a ring of very big stones which the picture shows. Some of the stones have fallen down and some have disappeared from the place. The people who lived in England in those days we call Bronze Age Men. Long before there were any towns, Stonehenge was a temple for worship and sacrifice. Some of the stones were brought from the nearby hills but others which we call Blue Stones, we think came from the mountains of Wales."

A picture accompanied the passage and the students were asked:

Question: Do you think Stonehenge might have been a fort and not a temple? Why do you think that?

Examples of Responses

1. Pre-structural

(a) "A temple because people live in it."

(b) "It can't be a fort or a temple because those big stones have fallen over."

Response (a) shows a lack of understanding of the material presented, and the implication of the question. The student is vaguely aware of "temple", "people" and "living", and he uses this disconnected data from the story, picture and questions to form his response. In response (b) the pupil has focused on an irrelevant aspect of the picture.

2. Uni-structural

(a) "It looks more like a temple because they are all in circles."

(b) "It could have been a fort because some of those big stones have been pushed over."

Although these students have focused on one aspect of the data, they have used it to support their answer to the question.

3. Multi-structural

(a) "I think Stonehenge was a temple because they wouldn't bring special stones from Wales to build a fort; they would just use nearby stones."

(b) "It might have been a fort because it looks like it would stand up to it. They used to build castles out of stone in those days. It looks like you could defend it too."

(c) "It is more likely that Stonehenge was a temple because it looks like a kind of design all in circles and they have gone to a lot of trouble."

These students have chosen an answer to the question (i.e. they have required a closed result) by considering a few features which stand out for them in the data, and have treated those features as independent and unrelated. They do not say, for example, that going to a lot of trouble to get material would be more typical of a temple construction, or that the middle of the plain does not provide a natural defence position.

4. Relational

> "I think it would be a temple because it has a round formation with an altar at the top end. I think it was used for worship of the sun god. There was no roof on it so that the sun shines right into the temple. There is a lot of hard work and labour in it for a god and the fact that they brought the blue stone from Wales. Anyway it's unlikely they'd build a fort in the middle of a plain."

This is a more thoughtful response than the previous three; it incorporates most of the data and considers the alternatives and interrelates the facts.

5. Extended Abstract

> "Stonehenge is one of the many monuments from the past about which there are a number of theories. It may have been a fort but the evidence suggests it was more likely to have been a temple. Archaeologists think that there were three different periods in its construction so it seems unlikely to have been a fort. The circular design and the Blue Stones from Wales make it seem reasonable that Stonehenge was built as a place of worship. It has been suggested that it was for the worship of the sun god because at a certain time of the year the sun shines along a path to the altar stone. There is a theory that its construction has astrological significance or that the outside ring of pits was used to record time. There are many explanations about Stonehenge but nobody really knows."

This response reveals the student's ability to hold the result unclosed while he considers evidence for both points of view. The student has introduced information from outside the data and the structure of his response reveals his ability to reason deductively.

(5) Understanding Historical Terms and Social Concepts

Wood (reported in Peel, 1967, p. 170) obtained data from students aged from nine to nineteen concerning their understanding of certain terms and concepts used in History, e.g. Parliament, committee, king.

He obtained a range of responses, which also typify the SOLO levels. In general, students' definitions may be classified in the SOLO Taxonomy according to the manner of definition:

Pre-structural: a personal (transductive) association which will most likely be irrelevant.

Uni-structural: one example, or one concrete attribute which the student has experienced.

Multi-structural: several examples and attributes.

Relational: a functional definition that is quite widely embracing, but still restricted to a known context.

Extended abstract: a connotative definition in terms of fundamental principles, and is applicable to all instances.

Some examples are reproduced below for the concepts of "King" and "Committee".

1. Pre-structural

(a) "The king lives in a castle far away."

(b) "A place like the Town Hall could be a committee."

These responses are based on transduction from the students' personal experiences, and are usually irrelevant in the context of the set task.

2. Uni-structural

(a) "The king lives at Buckingham Palace."

(b) "A committee is like the parents association at school."

These responses use denotation as a way of defining meaning, by giving one example for each item.

3. Multi-structural

(a) "A king is somebody very important and a king is very rich, a famous man out of a royal family."

(b) "A committee is a group of people at a meeting place, is a thing that helps the school."

At this level the students use several attributes, or expand on an example with a further description. Multi-structural responses are characterized by multiple "goes" at the concept. Again definition is by denotation.

4. Relational

(a) "A king is a ruler of a country."

(b) "A person who may rule his country by himself, may rule it in co-ordination with advisers or a government, or may simply be a figurehead."

(c) "The committee is the organising body of a society or similar institution, elected from the members of the same by the members."

Responses (b) and (c) are more accurate and elaborate statements than (a) but all describe the function of a king or committee rather than listing concrete attributes (Levels 2-3) or attempting an abstract definition (Level 5).

5. Extended Abstract

(a) "A king is a male sovereign ruler of an independent state whose position is either purely hereditary or hereditary under certain legal conditions, or, if elective, is considered to give to the elected the same attributes and rank as those of a purely hereditary ruler."

(b) "A committee is a body of two or more people appointed or elected by a society, or corporation or public meeting or similar institution, for some special business or function."

These responses are clearly more abstract. Concrete and functional properties might be included, but the term is explained in its widest sense, rather than being a description of a particular example.

(6) Inducing the Meaning of a Concept from a Context

In history, as in many subjects for that matter, it is often necessary to induce the meaning of a word from a context. De Silva (1972) thought that many teachers rely on the context of a word in a passage to give students an understanding of its meaning and related concepts. The results of his study indicated that without precise definitions and explanations also being given many students form narrow or logically restricted concepts. The test items constructed by De Silva consisted of ten passages from history texts in which a key word was replaced by a coded word. The students, aged between 12 and 16 years, gave a meaning to the coded word and the reason for their decision.

Example

Artificial word: MALMIR (slump, depression)

"The years that followed the victory of Waterloo were some of the worst that Britain ever passed through. The 'false and bloated prosperity' of the War, as Cobbet called it, gave way to a terrible malmir. The Government no longer needed to buy huge quantities of munitions and clothing for the army and the allies; the people of Europe after more than twenty years of war, were too poor to buy the goods that British manufacturers would have liked to sell; instead the foreign governments often used their discharged soldiers to make their own goods."

Examples of Responses

1. Pre-structural

"It meant a terrible disaster to the people of Britain, it gave way to a terrible disaster as it would say."

At this level students tend to replace the target word by a sentence which is an association with another dominating word in the passage, often the word immediately preceding the unknown word, as in this example. This strategy is basically a form of tautology ("a terrible terrible").

2. Uni-structural

(a) "It is a disease, because the soldiers that came back from the war brought back diseases with them."

(b) "Malmir means loss because the people of Europe were too poor to buy the goods."

At this level students give a simple unqualified response based on one aspect of the data or on one aspect of their experience with material related to the data.

3. Multi-structural

(a) "Poverty because they did not have any money after fighting the war and they couldn't sell their goods."

(b) "Redundancy, I think so because it said that Europe was too poor to buy things that Britain made because of twenty years of war. Also it said that European people used to make their own clothes."

In these responses, as typical of Level 3, a number of aspects of the data are included but only in the form of an isolated sequence of statements.

4. Relational

(a) "Poverty; when the people from the munitions factories were discharged they had to find jobs elsewhere and this was hard to do. The shortage of jobs meant a rise in unemployment and this resulted in poverty."

(b) "Uprising, if Britain could not sell what the manufacturers had made then some men might be out of work. The army would not be needed for fighting and so they might get sacked. The people of Britain might think that the government had done nothing to try and improve the situation and go against the government."

In each of these responses there is a realistic functional or relating concept that combines two or more pieces of evidence, and provides a possible explanation. This explanation is, however, tied to the particular context given.

5. Extended Abstract

(a) "Slump; after most wars the extensive munitions factories close down, perhaps some are converted to make cycles and other items like this. So many people lose their jobs which they held during the war. Secondly a large number of soldiers returning home from the war need jobs and there is not the demand in industry to create places in factories for ex-soldiers so a slump occurs."

(b) "Depression. A wartime economy is 'false and bloated' because it is based on excessive production to maintain the country's war effort. There is full or possibly excess employment because with men in the army many women are needed to work. They all receive wages so everyone has money. After the war many industries that supplied wartime goods are forced to close and in addition to the returning soldiers this creates unemployment. The selling

of manufactured goods is one way Britain could boost her economy, but since the European countries were suffering a similar depression there was no market for the goods. So depression occurred."

These responses appeal to a general principle, rather than to a given relating concept which enables the students to make logical inferences from the passage. The respondents go beyond the data to form an hypothesis, and then use the content of the passage to reason deductively to support it. As the question requires a one word answer it is obviously necessary to make a closure but their method of arriving at their selection reveals their ability to hold their choice open while they reason deductively. It can be noted that in this example only the extended abstract responses actually arrived at the "correct" answer.

Suitability of Items

The above examples make it clear that the SOLO Taxonomy is applicable to a fairly wide range of items or situations in history. While the particular characteristics of SOLO levels vary from item to item - what constitutes a defining feature depends entirely on the particular item content - enough examples have been given to illustrate a generality of structure across item-types.

In fact, the item content and structure is not all that important, provided that the task set, or question asked, allows higher level responses as being relevant. For example, a question that began "List the various factors that ..." is setting a Level 3 criterion for a satisfactory response, and students might see it as a waste of time to produce a Level 4 or 5 SOLO. "Compare and contrast ...", on the other hand, invites a minimum of a Level 4 or relational response.

Certain types of item structure are unsuitable for some populations. We have tried using old Bulletin cartoons (on squatter's rights, free trade, White Australia Policy, etc.) with Year 11 and 12 students but the cartoons were far too difficult: a uni-structural Level 2 response was the most common. The full appreciation of cartoons requires a rich background of contemporary topical detail, as well as a perhaps specific ability to appreciate visual metaphor and symbolism. Likewise particular items are sometimes unsuitable. We used the word COPTI (as an artificial word like "malmir") in a political context, but that particular letter combination suggested to half the students that the word was an acronym, e.g. Communist Organizational Party in Trade and Industry.

Reliability of Coding

Some data on the reliability of coding history items has been obtained. The items referred to in (1) and (3) above (letter from a convict; the British worker) were administered to 110 Year 11 and 12 students in six Sydney high schools by their class teachers. One of the writers drew up a list of "features" (or dimensions) for each item and 10 scripts were then coded by two assistants (a history graduate and a psychology graduate), after which conflicting codings were noted and discussed. The two assistants then recoded all the responses to each item, without being aware of each other's codings, and their codings were correlated.

Item 3 showed a higher degree of interjudge reliability than Item 1, possibly because Item 3 displayed a wider range of response (the convict letter elicited no Level 5 responses). The correlations between the two judges were +.81 (N = 107) for Item 3 and +.71 (N = 104) for Item 1; both figures are highly significant and are quite acceptable figures for data of this kind (being rather higher for example than essay scoring reliabilities).

The extent of agreement is shown in the following table:

	Item 3				Item 1			
	Agree	1/2 level diff.	1 level diff.	More than one level	Agree	1/2 level diff.	1 level diff.	More than one level
N	72	14	12	10	59	15	21	7
%	66	13	11	9	58	14	20	6

In the case of Item 3, two-thirds of the responses were coded the same way, with a half-level difference being next most common, one level next, and more than one level only 9% of cases. Similar figures apply to Item 1. These figures were obtained after 10 practice codings plus discussion; after 100 codings, no doubt these figures would be better still.

Thus, coding into SOLO levels appears to be readily learned and may be applied with a high degree of interjudge agreement. The remaining issue for discussion is how teachers may use the SOLO Taxonomy in the teaching of history.

Implications for the Teaching of History

It is not possible here to analyse completely or even in detail the ways in which the SOLO Taxonomy may be applied to the teaching of history. Such a task would ideally require a team of historian, teacher, curriculum expert and psychologist, not to mention much more space than is here available. The intention in this section is to set the ball rolling with a few observations, so that the reader may work on it in more detail for his own specific purposes.

As a first orientation to such a task, some consideration should be given to the nature of history, as an academic study. From this, we can then consider the aims of studying history in schools, and thence move in to the applications considered generally in Section B in the areas of Curriculum, Evaluation and Teaching Method.

Unlike mathematics and many of the sciences, as taught in schools, history is an "open" subject (Jurd, 1978). It is not possible, as it is in many of the natural sciences for example, to allocate causes to events with any high degree of certainty; or to isolate or often even to define what are believed to be crucial variables (how does one define "a critical trading position" for example?).

Marwick (1970) draws an elaborate analogy between the function of the study of history in a society and the function of memory in the life of an individual. In order to understand itself, and its relationship with the past and with other societies and cultures, society draws upon its memories; and as in the case of an individual, such use of past memory is selective, interpreting the past in light of present needs and understandings. Thus, the memory banks of either society or the individual are never fully known and are likely to be changed and reinterpreted in light of fresh knowledge and changing needs. It is for this reason that Jurd says that history must retain an open structure.

This general view of history may be categorised in the "romantic", as opposed to the "scientific", tradition (Burston and Thompson, 1967). According to the scientific view, the historian is an objective observer, piecing together "the facts" to form a true picture of what "really" happened. The recent controversy over Manning Clarke's biography of Henry Lawson indicates that the scientific view still has some adherents, but in general it is probably true to say that history as taught in schools is conceived more from within the romantic than the scientific framework.

In short then the historian's role - and therefore the school's function in teaching history - is to interpret the past in the light of

her own judgment and experience; not, as would be the case if history were a natural science, to "explain" history. Walsh (1967) suggests that historians structure their work in terms of "colligatory concepts", i.e. rather loose schemata or organising principles that help make a particular series of events understandable or more readily interpreted. This implies a perhaps paradoxical mixture of the general and the particular. As Burston elsewhere says (quoted in Jurd, op. cit., p. 292), "the special characteristic of history is its preoccupation with the individual event and its desire to show, not why revolutions occur, but the special individual nonrecurrent reason why a particular revolution occurred when it did". Whereas the natural scientist is given the licence to generalise within the proviso "all other things being equal", the historian's statements are made subject to "the situation being as it then was" (Dray, 1957), and are therefore limited to something less than generalisations. Indeed they have an inherent instability, as any one statement is likely to be drastically altered with a different perception of the elements of the situation that was.

Such a view of history and historiography entails special skills. In particular, in order to understand the relativity and personal or value laden nature of historical statements, the student needs to become personally involved in the subject in a way that is not so true of the natural sciences and mathematics. In particular, such personal involvement by the student means that he needs to develop a perspective that is contemporary; and in the case of high school students, this must mean a highly concrete, if not dramatic, presentation of history. Duckworth (1971-72) calls this involvement "exciting the imaginative response" in history and to facilitate it he suggests off-beat, even shocking, changes in perspective; e.g. "Read the following extract from Mein Kampf and then write a letter by a concentration camp guard trying to justify his treatment of the Jews". But these points are perhaps best left until the section on Method.

1. Curriculum and Evaluation

The first major question arising out of the above discussion on the nature of history is "Why should a subject of this nature be taught in schools?" The general answer is twofold:

(i) Socialising students: All students, regardless of ability or specific interest in history, should know something about the content of history, particularly as it is relevant to their own country, in order, for example, to understand their national identity, and, through a study of their

evolution, certain structures within their own society such as parliament, the public service, and so on. Second, there are processes or ways of thinking that are likely to be modified by a study of history that are similarly useful for socialised citizens; such might include the separation of fact from opinion, the ability to read original documents with understanding and with a critical allowance made for the perspective of the writer, the ability to reconcile conflicting sources of opinion, etc.

(ii) Preparing historians: This aim will be foremost, rightly or wrongly, in the minds of most teachers from Year 11 onwards. The aim of teaching in this view is to prepare those few students, with the ability and interest to do so, for further study in the discipline of history. These students will need to study both content and process aspects in greater depth than those studying simply from the point of view of socialising.

These aims of teaching align themselves well with those put forward by, for example, the N.S.W. Secondary Schools Board (1971); and for present purposes these may be taken as typical of statements by State Departmental Curriculum Bodies. On the nature of History, this document says:

> "History is ... a selection of facts, arranged, interpreted and generalised to be meaningful ... History develops imagination and an understanding of men and societies, while a study of the recent past is indispensable to understanding the present.
>
> "The objectives of this Syllabus are the acquisition of knowledge and the development of attitudes and values and skills." (op. cit.)

Knowledge objectives are divided into three categories: knowledge of facts, of concepts, and of generalisations. These correspond to content goals.

Skills or process objectives refer to 16 different skills that may be developed through a study of history, ranging from fairly low level skills which are not specific to history (such as library skills, recognising and recalling information, summarising) to quite high level skills which are specific to a study of history, given the nature of the subject from the preceding discussion. Some of the more important process skills would include the following (it will be recognised that several of the SOLO item examples given earlier illustrate some of these):

1. Drawing conclusions from a display of information such as a lesson or an original document.
2. Making value judgments about an historical event or character; and resolving the problem of the appropriate context for making value judgments (present; contemporary).

3. Realising what objectivity is and how difficult it is to attain; dissociating oneself from one's own ideology and time to make judgments about others. At the same time, there is the converse realisation that all historians are open to question on the grounds of the potential distortion due to their present ideologies and temporal context.
4. Recognising and reconciling fact and opinion, and drawing tentative conclusions; reconciling conflicting evidence from different sources.
5. Constructing a plausible interpretation from incomplete evidence.
6. Recognising that unlike scientific causes, historical causes cannot be assigned unequivocally, or with the assurance that, "all other things being equal", the same situation would lead to the same outcome (e.g. revolution, Act of Parliament, etc.).

Finally, the Secondary Schools Board recognises the importance of attitudes and values resulting from a study of history. Such attitudes include: awareness of the complex and interrelated nature of human societies; an appreciation of the ideas, aspirations and values of other peoples in other times; a sense of historical perspective ... "so that by a study of values held by other societies, students may be able to determine those values they wish to hold as part of their own developing philosophies of life" (ibid.).

The SOLO Taxonomy does not directly take into account the affective domain; indirectly, however, extended abstract responding is associated with the ability to appreciate the perspective of other people, and, as noticed in Section B, is associated with a deeper personal commitment to the subject under study. In short, then, we are here concerned with the first two aspects of teaching history, content and process aims. It is upon these that the SOLO Taxonomy bears most directly.

In deciding upon content areas for SOLO items, the teacher will be guided by the general documents put out by the various State and Independent syllabus committees or boards of studies. Nowadays these are very general, leaving a lot of individual choice to the classroom teacher to decide what particular topics should be dealt with in class. Whatever the decision, these topics would form the content of the SOLO items.

Some of the major process or skill features have been mentioned. These skills or processes are bound up with the teacher's conception of history; the "romantic" view of history would therefore emphasize the subjective interpretations that have been made by the historian on the documents under study, and the need for caution in interpreting them.

The conflicting documents about the life of the worker in Industrial Revolution England illustrated this point well, in that the higher SOLOs were obtainable only by considering the relativity and possible bias of one or both of the sources. Items could also be used which revolved around the particular colligatory concept used to present a certain sequence of events, and what alternative concepts might have been used to unify the sequence.

Having selected items in both content and process domains, then, the next important question is using them as instructional objectives. The major problem here is deciding what criteria correspond to "satisfactory" performance for the Year-group in question. In other words, what particular SOLO levels would define satisfactory levels for different groups of students?

Obviously, preselecting SOLO levels will depend upon the Year and future plans of the students being taught. Some students study history with a view to terminating at Year 10; their needs will clearly be different from those who intend to study history at tertiary level. Different Australian State Departments have more or less complicated "Levels" of study in a subject, particularly Year 10, and so relating SOLO levels to specific levels of study would be too complex to attempt here, although this is a matter that the classroom teacher who wishes to use SOLO would have to consider.

A look at this problem from another angle is provided by a study by Hallam (1967) who tested 100 pupils in an English Grammar school with history material, and classified their results according to the three levels of pre-operational concrete and formal. In many important respects, his upper and lower limits are equivalent to pre-structural and extended abstract. His term "concrete" covers a wide range: some of the lower examples would be classified as uni-structural and the higher as relational, although some of his (early) formal would be classified by us as relational. At any rate, there is sufficient overlap here to get some general notions about what kinds of responses might be expected at different Years. He compared students on both chronological and mental ages and found that mental ages were more reliable indices of level of response. This is important in evaluating his work for Australian conditions, as U.K. Grammar schools at that time were highly selective.

Hallam found that "16:2 to 16:6 years appears to be the chronological age at which formal thinking in history begins. It seems, however, that a mental age of 16:5 to 18:2 years is required for the beginning of the

formal stage ... concrete thinking in respect of history could be said to begin in the twelfth year" (op. cit., p. 191). Even at a mental age of 17:0, 12% of the responses were classified as "pre-operational"; and at a mental age of 10:0, only 10% of responses were classified as concrete, the rest being pre-operational.

Given the slightly different taxonomies and methods, and that Australian schools are now mostly nonselective, these data mean that we should not expect any extended abstract responses before Year 11, and then only from those students studying history in depth as an academic specialty. Unit 2, Unit 2A or "Modified" (or whatever the local term is for generalist study of history at Years 11 and 12) should not be expected to produce much in the way of relational responses; most would be at the multi-structural level.

The general issues here might be illustrated more concretely by an example of a Year 12 student studying generalist history. He was given the assignment: "Write an account of Japan's industrial development from 1904 to 1938". Before attempting it, he asked one of the present writers for some details of the more important dates and events by means of which he could structure the assignment. The suggestion was made that it might help to structure the assignment by looking at some of the tensions in Japan at the time, such as the highly conservative and traditional social structure, Emperor worship, and at the same time the strong need to compete with the West and obtain a Western-style standard of living. It was suggested that such a set of colligatory concepts might make the task more interesting and meaningful. At the least the writer thought that it would place the response at the relational level (the relating concept being the colligatory concept chosen). The student however replied that this was not what the teacher wanted. The teacher's requirements were a simple listing of the relevant details in some sort of chronological order.

This example illustrates the opposite danger to that pointed out by Hallam: in the effort to keep the level of the task down for the generalist student, the response expectation becomes too low level, encouraging the student to implement a minimal multi-structural strategy. (In fact, the sequel to this story is that the student a few months later withdrew from history on the grounds of boredom.)

Short of wholesale testing of various items - which should be done at some stage - a general guide for the teacher might be obtained from Table 1 in Section A. The minimum age for extended abstract is given as 16+ - the same as Hallam found in his study. Thus, we see that normally we would

expect some children to begin to display extended abstract SOLOs by 15, and relational by 13. However these are maximal figures, and the teacher must decide if a particular task warrants these higher levels as the minimum criterion for "satisfactory": for some tasks, it is possible that a multi-structural level would be adequate, and below about Year 8 is all that can reasonably be expected from most students.

(ii) Teaching Method

The setting of objectives at various SOLO levels in part determines the appropriate teaching method. Given that the relational level is still broadly classified as late concrete operations, the context even here needs to be real and one with which the child can readily identify; this is of course truer still when multi-structural responses are the target.

One point which does follow from this (see Table 1), and which Hallam (1969-70) also emphasises for different reasons, is that the number of "units" that the student can take into account is limited. For instance, at the uni-structural level the student attends to only two such units: the cue or question part of the item, and one aspect or feature that he relates to it (it is arguable that the relating operation itself requires another unit of attention in which case the student's total is three rather than two units, but in this discussion the unit-space for the operation is assumed). The relational response however requires at least four units: the cue, two or three units within the data, and the relating concept itself. Overloading the student with too much detail might easily force him to use a lower level strategy. Indeed the assignment on Japan's industrial growth is very likely an example of just this: the student was forced to attend to a crippling range of detail, which prevented him from being able to see the wood (the colligatory concept) for the trees and was in fact discouraged from seeing the wood. The effects of teaching history in Australian schools can be seen in a study by Connell (1970). He held semi-structured interviews with 149 children (5-16 years) from state schools in four suburbs of Sydney. Many children in the upper primary grades had little understanding of the Constitution even though they had received formal instruction. For instance, while they learn about political figures like the Queen and the Prime Minister quite early, it is not until about eleven years of age that children sort out the relationships these people have with political institutions. Until children do develop an understanding of the structure of the political world, formal constitutional arrangements have little meaning for them. Hence Connell found "wild misinterpretations of Parliament" in the upper primary grades and exagger-

ations of the powers of the Queen in the lower primary grades. On the other hand primary school children could grasp the political concept of elections, because they can relate this to their experience at school. Television news was nominated as the most important source of information and ideas about the political world; for only a few topics, such as national traditions and the constitutional structure, did the school appear as the main source. Connell found that high school students, who have the cognitive capacity to understand political institutions, hardly ever referred to the school as a source of information about politics, and he pointed out that this is the level where this information could be presented most meaningfully.

Perhaps these points illustrate the value of a qualitative monitoring of children's learning. It is quite possible to imagine that in a quantitative sense children can give the impression that they have learned several items, but in fact they may not have any clear notion as to how those items inter-relate either amongst themselves or with other items of knowledge. While the structural inter-relations amongst facts are of importance in the study of all subject matters, they are particularly important in the case of history, in which the "facts" are only as good as the colligatory concepts the historian uses to interpret them. The use of SOLO analysis forces attention to these relating concepts for any responses beyond multi-structural.

To summarise, SOLO analysis seems particularly useful in history. The applications generally follow the lines set out in Section B:

1. Analysis of curriculum into critical content and process components.
2. Selection or construction of items that exemplify the specific process skills required, using appropriate criteria.
3. Setting the SOLO level appropriately the Year and level of the student.
4. Using formative feedback from the class to adjust teaching.

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EXAMPLES OF THE TAXONOMY IN USE

2. ELEMENTARY MATHEMATICS

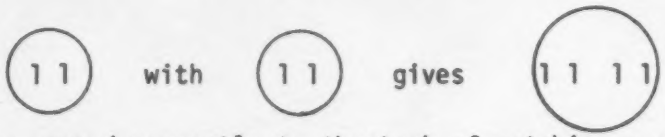
Section C: Examples of the Taxonomy in Use

2. Elementary Mathematics

It was mentioned in section A of this report that the SOLO model is readily applicable to elementary mathematics. However, the difficulty in making a direct application lies in the fact that the actual response made by the child does not indicate the complexity of the thought process which gave rise to that response. For example if a child is asked to find the value of "y" in y + 5 = 9 - and responds correctly with the answer "4" we do not know whether this has been achieved by the simple uni-structural device of counting on or by an extended abstract approach which would involve general principles such as inverse operations, associativity and so on. To find the complexity of the structure further probing is necessary. It is in fact this further probing, equivalent to the "how and why" questions in the other content areas, which trigger the responses that enable a judgment to be made regarding the SOLO level. The summaries of the response characteristics which follow assume this further probing.

1. Pre-structural Responses

At the pre-structural level "operations"* are not used by the student. Bases are being developed for the operational structures that will come later. Thus discussing responses to elementary mathematical items is irrelevant in this context because the child does not deploy the thought structures to handle numbers and their combinations meaningfully. That is not to say that a child at the pre-structural level could not answer the question: "What does 2 and 2 give?" However, being able to respond "4" does not necessarily mean that the individual possesses the knowledge or the experiences to be sure that a group of 2 elements combined with a group of 2 elements always gives a group of 4 elements, represented symbolically as



Being able to respond correctly to the task of matching a set of numerals with a set of 4 objects to be "counted" need not imply that the child understands the number idea "four".

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* An operation here is a mental action based on or developed from the physical act of operating on an object or situation in the environment.

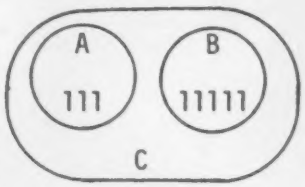
1	2	3	4
1	1	1	1
0	0	0	0

If one set of objects is spread out the child may now say there are "more". He or she is not yet able to comprehend the idea of invariance or conservation of number.

The pre-structural responses often indicate that the children are developing bases for operational thinking; this may be illustrated in their approach to many simple classificatory and prenumber tasks. However it is not until the next response level that the child shows that he possesses the necessary thought structures to handle number concepts, groupings, pairing corresponding elements, etc.

2. Uni-structural Responses

Responses at this level show that the child can only operate on elements based in immediately observable physical experience (e.g. 7 but not 759). Both the elements and operations of ordinary arithmetic are related directly to verifiable experience.

e.g. 

→ n(C) = n(A) + n(B) → 8 = 3 + 5

Responses at this level to items using large numbers, such as 75 + 111 = 186, tend to indicate that the child does not find them meaningful. In other words the responses show that the ability to work with addition and multiplication operations at this stage is tied initially to unions of sets of objects, either real or presented as an image, where the individual regards the result of the arithmetical operation as unique.

There should be no more than two elements connected by one operation and the uni-structural responses show that the student requires that this combination be actually replaced by a third element recognized as belonging to the same set (e.g. 3 + 5 = 8). The pupil needs to see that a unique and real* result exists. This need is termed a requirement for "closure", and may be seen as closely related to the apparent need evidenced in other content areas of coming to a quick firm decision on the basis of one datum. The idea of "inverse" incorporated in these responses is physical. For

* "real" here means part of the student's reality.

example, subtraction is seen as "what is put down can be taken up". No concept of the inverse as a process exists, the uni-structural response to the question, solve y + 4 = 7, would be to use a counting on procedure of some kind.

Uni-structural responses are not confined to young children but may be seen in the early years of the junior secondary school, for example, the difficulty some students have in understanding the concept of equivalent numerical expressions and being able to use it to simplify their working. They may see 2 + 3, 4 + 1, 3 + 2, as equivalent numerical expressions because the numerals and the basic numeral "5" are part of their experience and each expression may be closed. However the comparison of expressions like 476 + 233 and 234 + 475 presents numbers beyond their verifiable range and responses at this level are indicated by the student's need to make the actual replacements.

In summary then uni-structural responses are marked by a single direct relationship to concretely (either physically or iconically) available criteria.

3. Multi-structural Responses

Responses in this category are marked by an apparent ability on the part of the student to handle logical operations provided they can be applied directly to particular experiences. Operations are not related to one another nor abstract systems set up independently of experience. Thus, in working with addition and multiplication operations the pupil responding at this level regards the result of the operation as unique, i.e. closed. In other words the arithmetical operations must be able to be seen as reflections of reality - the sums and products must refer to real sets of objects whether present or not.

At this level of response the pupil still tends to work with qualitative comparisons like "the closer" or "the larger". Thinking depends on, and is bound by, the individual's perception of what is real and is marked by an inability to set up an empirical system based on measurement. Children responding at this level seem to be beginning to perceive a consistency between their qualitative comparisons which at times leads them to consider quantitative comparisons, but using additive procedures only. Thus the responses show that ordering elements by using direct excess comparisons is a common strategy but ordering or comparison by ratio is not.

Meaningful use of the four operations of arithmetic shows up only if the uniqueness of the result is guaranteed by previous experience both

with the operations and the elements operated on. If the elements are related to direct physical experience a number of elements may be considered. However if the elements are more abstract only two can be handled. This means that a pupil responding at this level will cope with items like 3 + 7 + 4 because the elements are verifiable and the 3 + 7 can be closed so that it still gives a verifiable element, thus allowing closure with 10 + 4 = 14. A second type of item that can be handled is, 475 + 234; here the operation is familiar and thus the process can be carried out because the pupil knows from previous experience that a unique result will always be found.

Multi-structural responses show that the student has developed the cognitive structures to enable pairing of equivalent elements. Thus success is achieved with items which require that pairs of expressions such as the following be shown to be equivalent:

(a) 6 + 4 + 3 and 3 + 8 + 2

(b) 475 + 234 and 476 + 233

Responses at this level also show that the level of closure required may be expressed as the felt need to believe that the outcome of performing the operation is necessarily unique, i.e. that two elements connected by one operation are replaceable by a third element from the same set but it is not necessary to actually make the replacement to guarantee this.

The illustrations above indicate why the responses may be classified as multi-structural. Although closure is still the ultimate guarantee of uniqueness there is no longer a requirement for an immediate direct relationship to concretely (physically or iconically) available criteria. The ability to handle multiple operations with small numbers by a series of meaningful closures, for instance, may be seen as analogous to using a sequence of given propositions to support a particular judgment in other content areas.

Finally the concept of "inverse" which comes through at this level of response is that it is a "destroying" process. Although in the classroom this kind of thinking is difficult to distinguish from thinking where the inverse is seen as an "undoing" process, the student's concept of the destroying process possesses an irreversible quality. For example, the student regards subtracting as destroying the effect of addition without specifically relating to the operations themselves; to find the value of "y" in y + 4 = 7, "y" is regarded as a unique number to which "4" has been added; subtracting "4" happens to destroy the effect of the original

addition. Probing usually reveals that the child explains his correct response to the question, not by referring to the addition and subtraction operations, but by adopting a more primitive strategy, i.e. counting or by saying the equivalent of, "that's how I was taught".

4. Relational Responses

Responses at this level seem to rely upon the same basic skills as underlie the multi-structural response level, the major advance appears to be that there is less reliance on "seeing" uniqueness in the results of operations even though there is still a requirement for uniqueness of outcome to be guaranteed. This guarantee of closure is obtained by making a generalization from particular concrete instances. The individual response shows that it is still bound to empirical evidence but that the respondent is now prepared to infer beyond what can be demonstrated by model, and to form a generalization from a number of specific cases. Thus at this level, where appropriate, the response takes the form of a concrete generalization where a few specific positive instances guarantee the reliability of a rule. Typically the responses indicate that the student is looking for positive instances to form a generalization, but that he is unaware of the need to check for counter-examples and constraining conditions. Moreover, as the response is based on the immediately available empirical evidence only, the student is unable to consider hypothetical instances.

Relational responses show an ability to handle generalized (apparently abstract) elements based on a few specific verifiable instances, e.g. $2a + 3a = 5a$, but the uniqueness of the result (the requirement of closure at this level) must still be guaranteed. In responding to questions related to statements such as the formulae $y = m \times s \times t$ these students show that they require, (i) that each letter stand for a unique number on any particular occasion, and (ii) that each binary operation involved be able to be closed at any stage. Because uniqueness is guaranteed and trial closures are possible, the student responding at this level should find little difficulty with items of the type:

(a) if $9 * 4 = 5$ and $7 * 2 = 5$,
what operation does * stand for?

(b) if $6 * 2 = 12$ and $5 * 3 = 15$,
complete $4 * 5 =$

A higher level of relational response is shown by the student who can handle items where closure is guaranteed (by the evidence of previous

experience) but where making the actual closure is not an efficient strategy. For instance,

> Decide whether the following pairs of expressions are equivalent:
>
> (a) $\frac{259 \times 416}{259}$ and $\frac{376 \times 416}{376}$
>
> (b) $(469 + 361) - 257$ and $(468 + 362) - 254$

Relational responses often show an <u>apparent</u> ability to work with operations and abstractions. Under questioning, however, one finds that the generalizations are concretely based. That is, the thinking is limited by the requirement that the uniqueness of the outcome of an operation must be guaranteed by experience. For example, the pupil might very well be able to determine that

$$\frac{382 \times 743}{382} \text{ is equivalent to } \frac{672 \times 743}{672}$$

but would not necessarily be able to understand and use meaningfully the generalization,

$$\frac{m \cdot a}{m} = \frac{n \cdot a}{n}$$

At this level of response the "inverse" process becomes an "undoing" of an operation previously performed. Thus it possesses a reversible quality, but is limited by the fact that it can only be applied to familiar operations. For example, the student may use the property that addition "undoes" subtraction, multiplication "undoes" division and vice versa to solve simple equations, but is not necessarily able to see that squaring "undoes" the square root in a simple surdic equation. Thus students responding at this level appear to be able to use an abstract rule that they have obtained from a generalization of a number of specific instances but they do not demonstrate the cognitive structures necessary to use the rule in a slightly different situation. For example, a student may derive the formula for the area of a rectangle ($A = \ell \times b$) by generalizing from a number of particular examples, and then appear to use the formula as if he had formed an abstract system. However, if a question is given that requires seeing A, ℓ, and b as variables instead of allowing A, ℓ, and b to be seen as unique, each representing a particular number, then the typical response at this level shows an inability to handle the problem. An example of this type of question is: "If a rectangle has length twice its breadth and its area is 72 square units, find its dimensions". Only

a student capable of responding at the extended abstract level will successfully solve this problem. The difficulty for the student operating at the lower level is that in a formula such as $A = \ell \times b$ each element must be seen as unique, that is, it must represent a number and a closed result is guaranteed as soon as a substitution is made. This necessity for a guarantee of closure which typifies responses at this level inhibits the ability to overview the data so necessary for an extended abstract response.

In conclusion then responses at this level are given on the basis of concrete generalizations where a few specific instances satisfy the respondent of the reliability of a rule and where the result of an operation, even though it be on apparent variables, is necessarily considered to be unique. In other words, the individual relates elements within the system and forms generalizations on this basis.

5. Extended Abstract Responses

At this level responses show that students reason and consider ideas at the abstract level without having to rely on experiences in the physical world. Thought at this level is based on deductive reasoning from any arbitrarily chosen hypothesis or premise. Abstract variables which may have a bearing on the solution to the problem are visualised and manipulated; responses are no longer bounded by concrete experiences. Respondents are no longer satisfied that one or two positive instances are a sufficient basis from which to generalize. The student responding at this level does not require operations to be actually closed; closure and uniqueness are looked upon as abstract properties of some systems that have certain implications. The ability to operate on operations is in evidence (at the earlier level the student is only capable of operating on elements) and so the student does not need to relate either the elements or the operations to reality in order to work with them. This ability to work without the requirement of uniqueness of the elements allows satisfactory responses to be made to items such as the following where the problem is to decide on the equality or otherwise of pairs of expressions such as:

(1) $a + b$ and $(a + 1) + (b + 1)$

(2) $a + b$ and $(a + 1) + (b - 1)$

(3) $(a + 1) \times (b - 1)$ and $(a - 1) \times (b + 1)$

(4) $(a - b) \times (a + b)$ and $(a - a) \times (b \times b)$

The level of difficulty here is a function not only of the degree of abstraction of the elements but also of the structural properties characteristic of the operations themselves.

Typically responses at this level show that the students concerned can accept lack of closure and that they are capable of dealing with variables as such because they can hold back from drawing a final conclusion until they have considered various possibilities, an essential strategy for obtaining a relationship as distinct from obtaining a unique result. For instance, given V = L x B x H they would not only be able to obtain unique results by appropriate substitutions in the formula but would also be able to discuss meaningfully the effect of various transformations on the formula, e.g. what would you predict for "V" if "L" was increased, "B" decreased and "H" held constant?

The inverse process is seen as an operation which is used to balance or compensate without necessarily affecting the existence of an earlier operation. As such it possesses a reciprocal quality. For example, an item such as

$$\text{if } (p * r) * q = (a * b) * q$$

$$\text{then } p * r = a * b$$

can be handled (the elements p, r, q, a, b and the operation "*", with its inverse, being suitably defined).

Responses at this level show that the student is able to see meaning in and work within an arbitrary well-defined but unfamiliar system. This ability allows the students to look on the propositions and conditions themselves as the reality - they do not require that a link be established with the physical world prior to working on a problem where the system is defined. They are able to work within a simple mathematical system and are capable of seeing inconsistencies in such a system.

In summary, the acceptance of lack of closure, the use of the reciprocal operation and the ability to work with multiple interacting and abstract systems all involve a comprehensive use of the given data together with related hypothetical constructs and thus match the characteristics attributed to the extended abstract response in the SOLO classification.

Examples of Students' Responses in Particular Mathematical Topics

So far the general aspects of the SOLO characteristics for different levels of functioning with mathematical material have been described. It now remains to take topics and/or concepts which are incorporated in most

mathematics curricula, either implicitly or explicitly, and relate them to the more general outline given above. It will be seen that the areas selected are concerned mainly with topics related to numbers and the operations thereon and are based on two major research reports (Collis, 1975a, b). The topics considered in order of treatment are as follows:

(1) numbers and operations;
(2) combination of operations;
(3) closure;
(4) pronumeral substitution;
(5) the inverse operation and elementary equation solving;
(6) preference for consistency;
(7) mathematical systems.

(1) Numbers and Operations

Uni-structural Responses

Uni-structural responses include arithmetical items which involve making one closure even where this requires making a comparison with a given result. The working memory capacity required is low and a quick closure is achieved on the basis of minimal use of data. For example problems such as the following can be solved:

(a) If q = 8 + 4 then q = ?

(b) 4 + 3 = ?

(c) If 7 * 4 = 3 then * = ?

With small numbers, items like (c) do not seem to present any more difficulty than items like (a) and (b).

Multi-structural Responses

Multi-structural responses typically show facility with large numbers involving single operations and a number of operations in sequence when the numbers are kept small. Each operation is closed in sequence so that the outcome of the sequence of closures gives a unique result. Several data are handled successively in the working memory by means of a sequence of closures. Some examples of the kinds of items the student operating at this level can handle are:

(a) n = (6 x 8) ÷ 4 n = ?

(b) (3 * 6) ÷ 3 = 6 * = ?

(c) $(2 * 3) * 4 = 9$ $\quad * = ?$

(d) $5 * 3 = 4 \circ 2$ $\quad * = ?$ and $\circ = ?$

At this level two closures in sequence can be handled and it does not matter when trials have to be made, as in examples (b), (c) and (d). For items with a single operation, large numbers are handled.

Relational Responses

At this level "generalized" elements (large numbers and pronumerals) are used and the idea of operations is generalized sufficiently to a stage where there is no longer a need to close each operation as it is dealt with. A guarantee of closure is still required but it is not represented by the need to close, in sequence, operation by operation. At this stage the student's experience with numbers and the reliability of the four operations of arithmetic used in conjunction with them seem to be sufficient. Items like the following should be able to be handled:

(a) $(4 \times 3) \circ 1 = 5 \circ (1 \circ 2)$ $\quad \circ = ?$

(b) $(3 \circ 4) \circ 1 = 12 * (6 * 2)$ $\quad \circ = ?$ and $* = ?$

(c) $(96 \times 42) \div 100 = (96 \times 21) \div 50$ Is statement True or False?

It can be seen that correct responses to items of this type are given the SOLO description of relational because the respondent is showing the ability to hold off actual closures while decisions are made regarding the interrelationships within the given statement.

Extended Abstract Responses

Extended abstract responses demonstrate a completely new level of functioning. At this level of response closure is looked upon in a mathematical sense, as a phenomenon which makes certain things possible - the reassurance provided by numbers and familiar operations is not needed. Problems with letters representing numbers or variables using any well defined operation are solved. With the ability to examine the item structure that the lack of a need to obtain immediately a unique result gives, responses in this category show an ability to consider the possibility of more than one answer to any item. Items like the following can be handled at this level:

(a) $(a \circ 3) \circ 4 = 8$ $\quad \circ = ?$ and $a = ?$

(b) 7 * 6 = 5 * 4 Is statement True or False? (Given a specific and unusual definition of the operation *)

(2) Combination of Operations

In a study (Collis, (1975b) designed to examine in more detail the development of the child's ability to handle combinations of arithmetical operations, students (10 years to 15 years) were asked questions which involved finding which of the four operations (+, -, x, ÷) would need to be substituted for the unknown operation(s) in order to make the statement true, e.g. (6 * 2) * 2 = 2, * = ?. In designing the questions the following criteria were used:

(i) small numbers (i.e. numbers less than 20) were used to avoid the interaction which these might have with the operations,

(ii) no more than two operations were involved in any one expression (e.g. expressions of the form 5 * 2 o 1) = 3, * = ?, o = ?),

(iii) some items used the same operation throughout and some used two different operations.

The students were tested individually as well as on a group basis, so that there was an opportunity to record how they were thinking. Of major interest in this context is the nature of the responses given by the children. Data was only gathered in relation to the three upper level categories of response, viz. multi-structural, relational and extended abstract.

Multi-structural Responses

Using the four operations of elementary arithmetic students responding at this level easily solved "two closures of the one operation in sequence" problems, e.g. (6 * 2) * 2 = 2, * = ? and could determine correctly the operation where two single and independent closures needed to be made, e.g. 8 * 2 = 11 * 5, * = ?. Moreover, when given the operations to try these students were able to deduce the value of an unknown number.

e.g. Look at this statement

3 * 4 = 6 * a

If this statement is true, then
(There may be more than one correct answer)

* could be x	yes	no	can't tell	If "yes" then a must be _____
* could be ÷	yes	no	can't tell	If "yes" then a must be _____
* could be +	yes	no	can't tell	If "yes" then a must be _____
* could be -	yes	no	can't tell	If "yes" then a must be _____

When the question involved two different operations the response strategy used by students operating at this level seemed to be to close on one operation and then either recognize a number pattern which would solve the problem or run through a series of trials for the second operation until a pattern was obtained. For example in the question 10 * 4 = 2 o 3, * = ?, o = ?, a typical student response was as follows:

> "If '+' is tried for '*'
> you get 14 = 2 o 3, which provides no recognizable number pattern, so a couple of trials on 2 o 3, e.g. 2 + 3, 2 x 3 - leave this side at this stage but 2 x 3 with 10 * 4 suggests '6' etc."

This method is not systematic nor very reliable as it depends too much on the pattern arising in the data fairly quickly, i.e. the data must be limited. No attempt was made by the children to record trials or eliminate possibilities and the turning up of the solution on many occasions seemed quite fortuitous. These kinds of responses clearly fit the SOLO description of multi-structural as the child, on being given the cue, tends to work with isolated but relevant data.

One of the most interesting results in this study was the general inability of students limited to this level of response to succeed on items like:

(i) If (4 o 2) o 3 = 6 o 4
and a o (3 o 6) = 4 o 9
find a,

even though they could in many instances successfully solve items of the form

(ii) (12 o 3) o 2 = 8 o 4, o =

and (iii) Look at this statement

(14 o 1) o a = 10 o 5

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If this statement is true, then

(There may be more than one correct answer)

o could be +	yes	no	can't tell	If "yes" then a must be _____
o could be -	yes	no	can't tell	If "yes" then a must be _____
o could be x	yes	no	can't tell	If "yes" then a must be _____
o could be ÷	yes	no	can't tell	If "yes" then a must be _____

The explanation which fits best seems to be that the problem lies in the difference between being given the operation(s) to make closures to find "a" (as in (iii)) and being forced to derive the operation(s) (as in (i)) to be used. Multi-structural respondents, in keeping with the SOLO model, succeeded in those items where the last part of the processing can be seen as independent of any initial processing. Responses showed that a couple of separate closures could be made and then the results compared so long as one closure did not impinge on the next. In other words the closures were performed in sequence without consideration of possible inter-relationships within the system.

Relational Responses

Students supplying this level of response successfully handled most of the items of the following form where the symbol "o" or "*" represented one of the four operations of arithmetic:

If (4 o 2) o 3 = 6 o 4
and a o (3 o 6) = 4 o 9
find a.

This level of response was also required to obtain correct answers to items involving two different but familiar operations closed in the one sequence, e.g. (4 * 3) o 2 = 2, * = ?, o = ?, or where sequences of closures were required on both sides of the equation, e.g. (12 o 3) o 2 = 8 o 4. The key elements for successful responses seemed to be an ability to prevent a result achieved in the first part of the sequence of operations from interfering with the next part to be processed. For example, to compare the differences in responses between students giving a multi-structural response and those giving a relational response, let us look at the way in which the latter tended to structure their reasoning in relation to the following item.

Example: (4 * 2) o 3 = 2, * = ?, o = ?.

"Try * = + which gives 6,
now 6 something 3 = 2, a pattern suggests itself,
namely, 6 ÷ 3 = 2
thus * = + and o = ÷."

The difference in strategy between the two groups in this study would seem to be the way in which the children giving the higher level of response re-oriented their thinking to focus on a <u>different</u> operation part way through a sequence of closures. In other words they were able to relate their reasoning at a subsequent stage to the result of a previous closure - the kind of response which is the essence of the SOLO description, relational.

<u>Extended Abstract Responses</u>

Students making responses in this category were much more likely to begin on either side of the equation (whereas lower level respondents almost invariably worked with the left hand side first) and to eliminate systematically certain possibilities with one operation first. For instance, a typical extended abstract response to the following item was as set out below.

Example: (4 * 2) o 3 = 2, * = ?, o = ?.

"something o 3 = 2 - deduction: o is not + or x as, under constraints, result is too large.

something - 3 = 2 - deduction: 4 * 2 must equal 5, not possible under constaints.

o 3 = ÷ 3

now something ÷3 = 2 - deduction: 4 * 2 must equal 6
∴ * = +

i.e. * = + and o = ÷ "

It will be noted that the extended abstract response is marked by a highly systematic, reliable and efficient approach. It involves combinatorial ideas together with a concern for the total system as expressed by the equation rather than with specific closures and pattern seeking. The introduction of combinatorial and systematic strategies typifies extended abstract responses.

(3) <u>Closure</u>

The development in children's thinking, both mathematical and otherwise, can be traced in terms of the need to "close" or come to a definite decision. At the earliest stage in mathematics, the mathematical expression must be able to be closed to a unique number to be meaningful to the child;

thinking then develops through a stage where a guarantee of closure must exist (but it is not necessary to make the actual replacement) to the final stage where closure is viewed simply as a mathematical property and the student is able to operate with variables in mathematical relationships.

In the present context, the level of closure at which the child is able to work with operations depends on the ability to regard the outcome of an operation (or series of operations) as unique and real, that is, part of the child's reality. The development of higher levels of reasoning in mathematics is closely related to the child's tolerance for unclosed operations. The closer to early concrete reasoning, the more the child depends on an immediate closure of the operation in order to make the situation meaningful. On the other hand the nearer to the top level of adolescent thinking the more it becomes apparent that the student can refrain from closing while the effect of the variables in the problem are considered.

The stages in the development of the child's acceptance of lack of closure with respect to mathematical operations is outlined below. The following table provides examples to illustrate the progression in the degree of closure the student requires as development moves from early concrete to formal operational thinking in this aspect of mathematical reasoning.

CLOSURE DIMENSION	EXAMPLES Are the expressions equivalent?
Closure possible	3 + 5 and 2 + 6 5 x 3 and 4 x 4
Closure an unsuitable strategy; however unique results guaranteed	(475 + 236) and (477 + 234) (479 x 231) and (456 x 231)
Closure not possible; uniqueness not guaranteed.	(a + b) and (a - 1) + (b - 1) (a + 1)(b - 1) and (a - 1)(b + 1) a x b x c ard d x e x f

This same sequence applies when the closure concept is looked at in relation to SOLO response levels.

Uni-structural Responses

The level of closure demonstrated by the child responding at this level is two elements connected by an operation which must be immediately replaced by a third element which is recognized as belonging to the same set, e.g. 3 + 5 is immediately closed to 8. In terms of numbers this means that this level of response makes available the four operations of elementary arithmetic when used singly with small numbers within the child's experience. Typically, the responses show that both the numbers and operations must be relateable, by the child, to the familiar physical world. Children responding at this level are able to decide that 3 + 2 = 5 and consider the statement meaningful, however this does not imply that they can replace 5 by 3 + 2, for example, in solving y + 3 = 5. In fact, if an individual is limited to this response level and asked, "find x in the following: x + 4 = 4 + 3", the typical procedure is to close the right hand side to obtain x + 4 = 7, and then use a counting-on procedure to solve the equation. Similarly, when asked to compare two expressions, the usual response at this level is to close both expressions to a unique number first and then compare the results. The techniques described define uni-structural responses in this area.

Multi-structural Responses

The level of closure required for this category of response involves the individual having the ability to regard the outcome of performing an operation as necessarily unique, i.e. the two elements connected by an operation are replaceable by a third from the same set but it is not necessary to make the actual replacement to guarantee this. The respondent at this level demonstrates that he can use numbers beyond the empirically verifiable range (e.g. 273 + 472) and can handle expressions involving (say) two or more operations which can be closed sequentially, e.g. (6 + 4 + 5).

Relational Responses

Responses in this category still show the need for the uniqueness of outcome to be guaranteed in some relatively concrete way. For example, because of experience with numbers and arithmetical operations the respondent may determine that the following pair of expressions are equivalent without resorting to the closure technique which would typify a lower level response.

$$\left(\frac{279 \times 412}{279} \text{ and } \frac{376 \times 412}{376} \right)$$

Another example of this same phenomenon is shown by students who are capable of working with formulae such as V = L x B x H provided they are able to consider that each letter stands for a unique number and each binary operation may be closed at any stage. This capacity to work within a given "concrete" context, using related aspects, clearly fits the definition of relational responses in the SOLO Taxonomy.

Extended Abstract Responses

Responses at this level indicated that closure is viewed as a mathematical property which may or may not exist for any set. Closure is not necessarily related to the student's empirical reality but can be applied to abstract elements and defined operations. At this level the adolescent can consider closure in a formal sense because of an ability to work on the operations themselves and without a need to relate either the elements or the operations to a physical reality. Responses at this level show that students can deal with variables as such because they can hold back from drawing a final conclusion until they have considered various possibilities - an essential strategy for obtaining a relationship as distinct from obtaining a unique result and the hallmark of an extended abstract response as defined in an earlier section of this report.

(4) Pronumeral Substitution

The ways in which students view pronumerals provides another example of levels in children's thinking and responding with elementary mathematics. In a study conducted in Nottingham, Collis (1975b) found that students' ability to work with pronumerals seemed to depend on what they were able to regard as "real" for them.

In discussing the students' responses at each level the following items will be referred to:

> "You are to decide whether the following statements are true always, sometimes or never. Put a circle round the right answer. If you put a circle round 'sometimes' explain when the statement is true." All letters stand for whole numbers or zero (e.g. 0, 1, 2, 3 etc.)
>
> 1. $a + b = b + a$ — Always / Never / Sometimes, that is when _____
>
> 2. $m + n + q = m + p + q$ — Always / Never / Sometimes, that is when _____

3. $a + 2b + 2c = a + 2b + 4c$

Always
Never
Sometimes, that is when _____

Uni-structural Responses

At this level of response the students saw each letter as representing one and only one number. Their approach was to map the pronumeral directly into a specific number - if this one trial did not give a satisfactory result they gave up working on that item. Responses of this kind are clearly uni-structural - the cue sets them off on a viable strategy but they use only one relevant datum. For example in response to item 1 they usually answered "always" on the basis of trying a number for "a" and another for "b". The fact that the student operating at this level gave the required answer "always equal" merely meant "it is true because I tried 'a = 3' and 'b = 4' and it worked". The next two items proved impossible for these students.

Multi-structural Responses

Students giving responses at this level tried a couple of numbers and if they satisfied the relationship they drew their conclusion on this basis. These students were able to solve item 1 because they were relying on a number of specific numbers to replace the pronumerals, however they were unable to handle items 2 and 3. Again the responses fit the SOLO model at the multi-structural level as the students clearly used several relevant but isolated data in the form of 2 or 3 trials of different sets of numbers - the latter being selected apparently quite at random.

Relational Responses

At this level the students seemed to have extracted a concept of "generalized" number by which a symbol "b" say could be regarded as an entity in its own right but having the same properties as any number with which they had previous experience. They had not developed the concept of pronumeral well enough to consider it as a variable but thought instead of the letters in the items as representing "all the numbers which one would readily think of". These restrictions limit the students' responses to the SOLO level relational, as they confined their attention to inter-relationships within the concrete data as they saw it - not thinking beyond it to the whole cardinal number system.

Even though the responses showed that they possessed the concept of generalized number, students responding at this level were unable to cope

adequately with the problem of making the necessary deduction in the final step of items 2 and 3. In reasoning aloud in item 2 the student at this level seemed to check off "m" and "q" on each side with a comment like, "It doesn't matter what number they are, they will be the same and cancel out one another". Then when considering n = p the reasoning went along the lines: "Ah, n equals p. How can it? Hmmm, it does not matter what n and p equal ..." and then the decision n ≠ p was taken and the "never" response selected. It appeared that the correct answer required a reconsideration of the given information, a standing back from the notion of "all the numbers one can readily think of" and a consideration of a super-ordinate concept. The students concerned were unable to do this. To them, n varying over a great range at the same time as p is varying over the same range made the probability of them meeting on any one element so remote as to be inconceivable - they were clearly bound to the here and now data of generalized numbers.

Again with item 3 students responding at the relational level were unable to make the final deduction from the statement 2c = 4c. They were not able to think of an occasion when 2 x (a number) would equal 4 x (a number). It is the next level of abstraction, that of a pronumeral as a variable, where thinking of zero occurs so that the number system is consistent with itself.

Extended Abstract Responses

Responses in this category demonstrate an ability to view a pronumeral as a variable and thus enable the final deduction necessary in items 2 and 3 to be made. For item 2, a student capable of working with variables has the ability to conceive of the possibility that with n and p varying over a range of numbers there can be a situation where the equality holds and so can answer "sometimes, that is when n = p". Likewise for item 3 a similar kind of reasoning resolves the problem of 2c = 4c by allowing c = 0. These responses are classified as extended abstract because they demonstrate the use of high level logical skills, an ability to account for all possibilities and, in this case, an ability to overview the problem in terms of an abstract self-consistent system.

Further information on the way in which a student's view of pronumerals affect his level of response was found in another study which was designed primarily to investigate students' ability to solve simultaneous equations by matching and substitution techniques. For the matching procedures examples of the following kind were given - "Find the relation between

p, q and r (only) given that:

$$\begin{aligned} &(\quad p + a = c \\ &(q + r + a = c" \end{aligned}$$

It was thought that a likely approach in this type of exercise would be matching "a" with "a" and "c" with "c" thus leading to the conclusion $p = q + r$. On the other hand, the following type of problem was used to encourage the children to use the substitution procedure - "Find the relation between h and mp (only) given that:

$$\begin{aligned} &(\quad h = a \\ &(\quad mp = b \\ &(a + b = 180" \end{aligned}$$

It seemed reasonable to hypothesize that the student would substitute in the third equation to obtain $h + mp = 180$.

Two developing areas of thinking in relation to these types of questions became clear. First, there appeared to be a growth from considering the various letters as unique numbers to a view of them as generalized (but unique on particular occasions) numbers, and finally, at the formal operational level, to the realization that the letters could be considered as variables. Second, there appeared a struggle to keep control of the problem long enough to pin down the relationship which was felt to be there. Sometimes this was reflected in a last minute breakdown as when a thirteen year old student said aloud (and correctly) in response to the following item:

find $\overleftarrow{x}^{0}\overrightarrow{y}$ if

$(x + a + b = 180$
$(y + a + b = 180,$

($\overleftarrow{x}^{0}\overrightarrow{y}$ means write down an expression with x and y in it but no other letters)

"Ah, x must be equal to y", but then after looking again at the question wrote "x + y = ...".

By considering the students' comments as they worked out loud or tried to explain what they were thinking, a consistent progression in levels of response could be seen and described in SOLO terms. These are outlined below.

Uni-structural Responses

At this level of response the students spoke as if each letter stood for one and only one number. In attempting to obtain a relationship these students tried to find the number that was the answer. The typical approach at this level was a guess at a particular number even though the student realized that the task was to find a relationship. For example,

find $\overleftarrow{x}\,\overrightarrow{y}$ if

(x = a
(y = b
(a + b = 180

the approach of the student operating at this level tended to lead to answers of the kind x = 90 and y = 90. The responses were uni-structural in that a relevant piece of data was used but its use alone led to a closed but incorrect result.

Multi-structural Responses

Students responding at this level used trial and error attempts to substitute numbers in some exercises as if they felt one could try out various numbers for the pronumerals and that eventually the number would be found which was the answer. In seeking relationships they seemed to have an intuitive feeling for an appropriate relationship but often fell down because of their inability to disentangle their thoughts from the "number" problem. The more information that was obtained about a relationship (say) by trying various numbers, the more difficult it became for the student to focus on the relationship itself. For example, in response to the item:

find $\overleftarrow{x}\,\overrightarrow{y}$ if

(x + a + b = 180
(y + a + b = 180

Having substituted several numbers for "a" and "b", the student might even say aloud that "it looks as though x = y", but after a little more thought (or work) would write "x + y = " and stop, clearly puzzled.

Another illustration of the limitation implicit in this level of response is provided by the following reasoning given by a 12 year old student,

find $x\overleftarrow{y}\overrightarrow{z}$ if

(x + 20 = b
(y + z + 20 = b

"I'm trying to find out if x and 20 equal b.
How can y and z and 20 equal b?
They must all equal the same amount.
How can you write that down?"
Then wrote x + y = 20.

Often this same difficulty of holding only the relevant information and making the final deduction was shown up by the ease with which one or more of the letters would get lost or at least have no observable account taken of its existence.

Because of these limitations to their thinking, students responding at this level found it much easier to cope with the task of finding a particular number in a simple $x = y$ relationship than to establish a relationship of the form $x + y =$ constant or $x + y = z$.

The responses were typically multi-structural because, although the students were taking into account several relevant data, they were not inter-relating them in such a way as to allow the relationship sought to surface.

Relational Responses

At this level of response the students demonstrated that they had the idea of "generalized" numbers - if necessary one could be specific but, in contrast to responses at the previous two levels, there was no real need to be. In responses classified as relational, the symbol seemed to operate as an abstraction but not yet in the form of a variable as such because it was still dependent on both the set of numbers and the kinds of operations with which the student had had experience.

With relational level responses the student appeared to be able to see a relationship coming up and was able to sort it out because of his way of seeing pronumerals as generalized numbers. For example,

find y if

$$\begin{cases} y = b \\ y + 2b = 90 \end{cases}$$

the student responding at this level tended to work thus:

"b is a number
2b is twice that number and thus twice y
y + 2y makes 3y and so y = 30".

Responses would be identified as relational because they demonstrated the student's ability to see the inter-relationships between several aspects of the data.

Students operating at this level seemed to have more processing space available for the final deductive steps because their thinking was not cluttered with a large number of specific examples which, together with the original statements, had to be taken into account in the final step.

Extended Abstract Responses

Responses in this category showed clearly that the students saw pronumerals not only as "generalized" numbers but also as variables. Relationships and systems of equations were handled readily. The ability

to view pronumerals as variables seemed to allow students to make the necessary deduction in the final steps of items such as the following:

find $\overleftarrow{x}^{0}\overrightarrow{y}$ if

$$\left.\begin{array}{l} \\ \\ \end{array}\right(\begin{array}{l} x = a \\ y = b \\ x + a + y + b = 90 \end{array}$$

where a substitution technique was required.

Related to the growth in thinking about pronumerals is the development of thinking needed to work within a well-defined mathematical system. To view pronumerals not only as generalized numbers but also as variables and to be able to express relationships among variables are necessary concepts for an appreciation of abstract mathematical systems. Thus the discussion of the growth of a student's concept of pronumerals will be taken up again later in this section in relation to the development of the ability to work within simple and complex mathematical systems.

(5) The Inverse Operation and Elementary Equation Solving

The problem of solving a simple equation such as $y + 4 = 7$ can be used to illustrate the different SOLO response levels associated with a student's concept of the inverse.

Uni-structural Responses

The typical response at this level shows that the problem is seen as a counting task; to find y the student counts on from 4 until 7 is reached and records the number of units used. Responses at this level seem to indicate that the only notion of the inverse is physical, i.e. what is put down can be taken up. There is no understanding of the mathematical implications of the operation, addition; the + sign is only a stimulus to set the student counting to find the solution. The response made is clearly uni-structural in that presentation of the cue triggers off one relevant strategy only, the child being unable to consider alternatives. For the pupil who is unable to find the solution the teacher who says, for example, "what must you add to 4 to get 7" is encouraging the child to solve the problem in terms of the thought structures which will elicit a uni-structural response - a quite appropriate procedure for most children in the lower primary school. A uni-structural response does not allow for any possible connection between say, $x + 4 = 6$ and $x = 6 - 4$ and a student fixed at that level will even deny that the latter is an appropriate method of finding the value of "x" in the former.

Multi-structural Responses

The typical respondent at this level indicates that he sees both sides of the equation as representing a unique number and the inverse operation as a "destroying" process. Thus the student at this level sees the problem as: "y" is an unknown but unique number and so is "y + 4"; the latter has been obtained by "plussing 4" to "y" and thus "y" can be found by subtracting "4" from "y + 4" which happens to equal "7", therefore y must be 3. The student sees the negating mechanism as destroying the original operation and thus there is no hint in his response that the operation might be reversible. These students readily agree to the viability of the following procedure:

$$x + 4 = 6$$
$$\therefore\ x = 6 - 4$$

Their basic weakness lies in their inability to see the process as reversible but this, in turn, is the key to defining responses of this kind as multi-structural; the child sees more than one adequate strategy (the "counting on" or subtraction) but they are not necessarily connected or inter-related.

Relational Responses

Responses at this level are indicated by the child seeing the inverse as an "undoing" process. In practice this level is difficult to distinguish from the process at the multi-structural level in that the pupil still sees both sides of the equation as representing a unique number, and operates as before, viz. $x + 4 = 6$, ... $x = 6 - 4$, ... $x = 2$. However the negating mechanism, if seen as an undoing process, possesses a reversible quality. This allows the student who is responding at this level to use a reversal of steps as a method of checking the reasoning, e.g. in the example just given it could go thus: $x + 4 = 6$, $x = 6 - 4$, $x = 2$, $x + 4 = 2 + 4$, $x + 4 = 6$. This ability points up the relational concept in the SOLO Taxonomy. The inter-relationships within the data become clear when the response demonstrates the awareness of the reversibility of the operations involved. An advantage of being able to view the inverse operation as an "undoing" operation, not as a "destroying" operation, is illustrated by the following example involving simultaneous equations:

Solve simultaneously: $\begin{cases} 3x + 2y = 4 \\ 3x = 2y = 1 \end{cases}$

The student who is only capable of responding at the multi-structural level will use meaningfully the method "add to eliminate the y's, find x, then substitute to find y" if it has been taught, because it allows an immediate closure followed by the use of a familiar operation (substitution) with one pronumeral. However the student at this level tends to view the elimination step as an operation where the -2y destroys the +2y and alters the original system. Responses indicating this type of functioning are well classified as multi-structural because of the discrete and separate closures made without consideration being given to the inter-relationships inhering within the given system.

For the student who is capable of responding at the relational level the following procedure is also available:

$$\begin{aligned} &(3x + 2y = 4 \\ &(3x - 2y = 1 \\ &\quad 6x \quad\;\; = 5 \\ &\quad\;\; x \quad\;\; = 5/6 \end{aligned}$$

$$\begin{aligned} &(3x + 2y = 4 \\ &(3x - 2y = 1 \\ &\quad\;\; 4y = 3 \\ &\quad\;\; y = 3/4 \end{aligned}$$

This reasoning may be described as follows:

> "By adding the two equations -2y negates +2y so one obtains 6x = 5, x = 5/6. However the original equations are not altered or 'destroyed' by taking this step, so y may be found (more easily than by substitution) if one starts again with the original equations. By subtracting the two equations +3x is negated by -3x, and the other solution, y = 3/4, is obtained."

This kind of response may be regarded as relational because it demonstrates awareness of the relationships within the system.

Extended Abstract Responses

This level of response is indicated when questioning and appropriate examples show that the student focuses immediately on the operation involved and does not need to regard either side of the equation as unique and necessarily empirically constant. For example in the statement $x + 4 = 7$ the 7 can be replaced by any one of a number of expressions (3 + 4; 15 - 8; etc.); x could be variable or constant. The problem for the student is to find the operation which will operate on the given operation in such a way as to negate it without upsetting the existing state of the relationships and allowing for the possibility of returning to the original statement. In the present example subtraction is the appropriate annulling operation

and it is convenient to use the subtraction of "4" in order to isolate "y"; likewise the "7" can be replaced by 3 + 4 for convenience. The reasoning might be recorded as below and students capable of this level of response, in contrast to those capable only of earlier levels, will see the point in using the procedure.

$y + 4 = 7$

$y + 4 - 4 = 7 - 4$ (negating the addition operation, choosing a convenient number and maintaining the relationship)

$y + (4 - 4) = 3 + (4 - 4)$ (replacing 7 by a convenient expression and re-associating)

$y + 0 = 3 + 0$ inverse axiom

$y = 3$ identity axiom

This example illustrates the difference to be expected between responses classified as extended abstract, relational and multi-structural; the non-reversible negating process is still data-bound but takes account of some relationships within the existing data, the reciprocal process is quite abstract and takes an overview of the total abstract system involved not merely the immediately present data.

These two concepts of the inverse, "negation" and "reciprocity" have been clearly distinguished (Inhelder and Piaget, 1958) in relation to material other than mathematical material. The former term is used when the operation is annulled directly and the latter when the operation is left untouched while its effect is neutralised. In the classical beam balance experiment, for example, adding a weight to the left hand pan is negated by removing it, but the same effect can be obtained by adding the same weight to the right hand pan - a reciprocal strategy. The point is made that it is not until the formal operational level of reasoning is attained that the student has both strategies available. It is suggested here that the method described to isolate "y" in $y + 4 = 7$ shown by the extended abstract response represents the reciprocal strategy and that the relational and multi-structural responses use variations on the negation strategy.

In mathematical material there are many occasions where the reciprocal strategy is essential rather than optional, as an attempt to use negation in such cases often gives rise to serious errors. Some of these occasions are due to the following:

(i) the order in which operations are performed is important;

(ii) an operation often has to be performed on an expression as a whole and not on one of its constituent parts;

(iii) an operation or a series of operations has to be performed while retaining the original expression in a particular form.

For instance, to clear the fraction out of the equation,

$$\frac{x}{2} + 3 = 7 - 2,$$

it is necessary to multiply throughout by 2, that is, $x + 6 = 2\ (7 - 2)$. However, a student, using only the negation strategy, may apply the obvious procedure, namely,

$$\frac{x}{2} \times 2 + 3 = 7 - 2$$

and so destroy the original relationship. That is, using the inverse simply as a negating mechanism means that the student operates immediately and directly upon one operation or the last operation performed without necessarily considering its effect on any other operation which may be interacting with it. Whereas using the inverse operation as a reciprocal strategy takes into account interactions between the various variables involved. The reciprocal strategy may well involve compensatory action instead of direct action on the variable concerned.

The development of the student's use of the inverse operation from a negating to a reciprocal procedure may be seen to illustrate one of the important aspects of the development in a child's thinking in this context and one of the teacher's tasks in this area might well be seen as attempting to raise the level of the student's response structure.

A brief note on the solution of inequalities: The way in which students handle this topic is related both to their strategies for solving elementary equations and to their ways of viewing pronumerals and thus SOLO response levels can be readily applied to this area also. Since the concrete operational thinker sees both sides of the equation as representing unique numbers a statement of the form $y + 3 < 7$ presents difficulties. Students operating at the concrete level can be "taught" to solve these, often through being told to treat the "<" sign as an "=" sign and then to proceed as with equations. This method allows the students to obtain a satisfactory answer but until they can see that y may be a variable they are unable to grasp the implication of the solution $y < 4$. This is revealed when the student is required to use the solution in some way, for example, to write the solution if y belongs to the set of positive integers. The inability of the concrete thinker to view y as a variable and hence interpret a solution is also illustrated by a student who can give a solution as $y > 1$ and $y < 3$ but who fails to see that this may be expressed as $1 < y < 3$. It is not

until the students are capable of responding at an extended abstract level and can view a pronumeral as a variable that they can approach equation solving in general by dealing with the operations and relationships themselves. Thus real success with equations and inequalities is not likely to be achieved before the stage of formal operations has been attained.

(6) The Development of a Preference for Logical Consistency in Mathematics Material

One of the necessary conditions in developing and using a clear-cut logical strategy in problem solving would seem to be an ability to be aware of the necessity for the same results to be obtained consistently from the use of the same elements with the same operation.

In a study (Collis, 1975a) designed to look at the ways in which students between the ages of nine and sixteen years handle logical inconsistencies in mathematical structures, it was found that one of the ways by which lower level student responses could be distinguished from higher level responses was by considering the individual's ability to be aware of and resolve inconsistencies in a logical manner.

The test material gave students experience in mapping two or three elements into one by using an unfamiliar operation. The students were obliged to use one of two tables to carry out each mapping. One table (A) gave consistent results on all occasions, the other table (B) gave inconsistent results on some occasions. All students were given practice in using both tables A and B and were then asked to indicate which table they preferred to use and to write down the reason for their preference. The reasons that students gave for their preferences fell into four categories. These are shown below with examples of the typical reasons given by the students. To have a response classified as category 1, the student had to satisfy three criteria:

(a) choose Table A;
(b) give the explicit reason of consistency for the choice;
(c) show evidence in the responses to the exercises that sometimes there were at least two possible responses if Table B was used.

The results clearly showed an increasing preference for the consistent table with age. Moreover, the results reflected similar changes from concrete to formal operational levels of thinking shown in previous studies using other mathematical material. Until about age eleven years, when the consistent table was chosen, it was done so for irrelevant reasons, but from this age onwards there was a gradual improvement in the reasons given,

Response Categories

1. Table A chosen for consistency and this fact stated explicitly	Table A consistent, Table B inconsistent, in Table B some results contradict others, Table B has double answers, Table B has two answers to one question
2. Table A chosen but consistency not mentioned or necessarily implied in reason	Table A looks better than Table B, answers from Table A make more sense, Table A easier (clearer) to understand, Table A gives better answers than Table B
3. Table A/B chosen for irrelevant reason	Table A/B on top, Table A/B chosen as name starts with A/B, Table A/B as favourite letter is A/B, Table A/B because I like it
4. Neither table preferred	Both gave adequate answers, both just as easy, both meant the same, because it does not matter which you use, because result the same

until a sudden rise at age sixteen years. This seemed to indicate that between the ages of eleven to sixteen years students have a "feeling" for consistency in mathematical material, but it is only at the end of this age range that they are willing or able to express explicitly the preference for consistency or the need for consistency in material to which they are applying logical thought structures.

It is also clear from the study that the more adequate responses show a more sophisticated structuring of the data presented and thus it is appropriate to relate the results to the SOLO model.

Pre-structural Responses

Category 4 responses are best described as pre-structural: the students did not fully comprehend the problem. Although these children handled the practical exercises adequately they were clearly unaware that consistency of result was important. These responses seem to reflect thinking at the pre-operational level with respect to items testing an awareness of logical consistency. It should be remembered, however, that the students at this level are still forming bases for operational thought structures, thus the types of responses obtained may be regarded as preparatory to the significant advance in thinking which seems to occur at about ten or eleven years, where the student first begins to demonstrate a feel for the need for logical consistency in mathematical material.

Uni-structural Responses

In category 3 responses the student vacillated between choosing the consistent and inconsistent tables and there was an inability to give adequate reasons for the particular choice. The uni-structural nature of these responses is evident from the fact that these students were prepared to make a choice on some grounds, perhaps intuitive, but because the grounds for choice were limited and isolated they as often chose one table as the other.

Multi-structural Responses

Category 2 responses, where students chose the consistent table but were unable to give adequate reasons for so doing, are typically multi-structural. The students took enough of the data into account to choose correctly but were unable to inter-relate them sufficiently clearly to be able to focus on the logical reason for their preference.

Relational Responses

Category 1 responses reveal the students' ability to integrate all the data presented and then focus on the appropriate underlying general principle upon which these judgments were based. It should be noted that the nature of the study virtually precluded extended abstract responses - thus students capable of this level of response were constrained to relational responses.

(7) Mathematical Systems

(a) Working within a Defined Mathematical System

This type of problem abounds in elementary mathematics. The students are given definitions for the elements and the operations peculiar to the system and then required to make deductions within its constraints. Algebra and Geometry are obvious examples, but less obvious examples are contained in the areas of elementary arithmetic. Fractions, for example, fit the pattern beautifully but so also do many topics in so-called practical arithmetic. Hire purchase, Commission and Discount, Stocks and Shares are typical examples of the latter.

As a generalized example let us consider the following question: "a, b, c, ..., etc. can be any of the numbers 0, 1, 2, 3, ..., etc. and * is an operation such that $a * b = a + 2 \times b$. Examine each of the following statements and indicate when each statement will be true.

1. $a * b = b * a$

2. $a * (b * c) = (a * b) * c$

3. $a * d = a$

4. $a * (b + c) = (a * b) * c$

5. $a + (b * c) = (b * c) + a$."

In the study (Collis, 1973) where this item was used it was found that only students at the formal operational stage of reasoning had any degree of success. However, the main interest here lies in the nature of the responses which were forthcoming from those who did not succeed. As will be seen they conform to the SOLO model and are important as general indicators of the kinds of responses which are likely from students attempting to work within a specific system such as fractions or hire purchase where the system and the operations within it are defined quite arbitrarily as far as the unsophisticated student is concerned.

Pre-structural Responses

Typical comments from this group indicated a disinclination to attempt to come to grips with the data at all. "Can't tell" and "Have not learnt those yet" were frequent responses.

Uni/Multi-structural Responses

The data gathered in this area is insufficiently precise to clearly distinguish the two levels of functioning. The responses which fit these categories were ones where the students did not accept the system as defined but substituted for it a familiar system which they felt was analogous. Typical responses to items 1 and 2 were "True, when * means + or x". The lowered working memory capacity represented by these responses, the "generalizing" in terms of a vague similarity with a familiar system and the apparent lack of concern for consistency are all hall-marks of these lower level SOLO descriptions.

Relational Responses

A response at this level showed that the student was aware of the fact that he had to use the defined operation as such and not translate it into a more familiar operation, but that he did not have sufficient control of the system to be able to deduce the correct results. A relational as opposed to an extended abstract response indicated an ability to note the

inter-relationships existing in the data given but an inability to transcend these so that an overview might be obtained which would give a complete resolution of the problem.

Examples of typical responses at this level follow.

Student A

1. When $b * a = a + 2 \times b$
2. When $a * b = b * c$
3. When $a = a + 2d$
4. True if $a + 2b = b + 2c$, i.e. $a * b = b * c$
5. True if $a * b = b * c$.

Comment: this student was aware of the necessity to use the defined operation but was unable to take the next step of making a deduction within the system.

Student B

1. $a + 2 \times b = b + 2 \times a$
2. $a + 2(b + 2 \times c) = (a + 2 \times b)\ 2 \times c$ etc.

Comment: This student could use the defined operation but seemed unable or unwilling to draw a conclusion.

The students could generalize sufficiently from their experience with operations to use the defined operation correctly but were unable to go beyond the information before them to make the necessary deductions about the variables.

Extended Abstract Responses

Responses at this level showed the ability to work correctly within the defined system. Based on this study extended abstract responses in this area follow this pattern:

(1) expanding each side of the equation in item 1 in terms of the definition thus:

$a * b = a + 2 \times b$
$a * a = b + 2 \times a$ } Note: a typical relational response to this point

and drawing a correct conclusion;

(2) perhaps following this same procedure for items 2 and 3;

(3) finally displaying ability to reason with defined operation without expansion step.

The first step in the above pattern is very significant. It appears to support the intuition that an extended abstract response will only be obtained in an area where the individual has had sufficient experience with the concrete data pertaining to that area. The amount of experience required in a particular case is very much a function of the person's general sophistication in the area.

There are a number of important implications for school mathematics programmes and methods of teaching in what has been indicated in this section on mathematical systems. Mathematics teaching in recent years has shifted its emphasis from the development of computational skills to the understanding of the structure in the subject matter and thus the temptation to present systems formally and then ask students to make deductions within the system has increased. The work outlined above shows that the general run of school children, particularly the junior secondary level, cannot handle work presented in this way. Fractions are introduced in primary school, but if this topic is presented as a formal system with new meanings for the four arithmetical operations, primary school children are not able to give meaning to the system and teachers are forced to resort to teaching computations by rote procedures. Moreover, the SOLO descriptions should help teachers detect the forms of malfunctioning which are generated by too early introduction of a topic which conforms to the general model described above.

Another area where school procedures typically outstrip the average student's level of cognitive functioning is mensuration. For example, if the calculation of the area of a rectangle is presented as a formal system, i.e. "If a surface is rectangular in shape, the area is found by the formula $A = L \times B$, where L is the length and B is the breadth. The area will be in square measure and when this formula is used L and B must be in the same units", the student responding at the relational level will have great difficulty relating the problem to his previous experience. As a result, students operating at this level will usually be able to perform satisfactorily on exercises set for class practice by following a standard teacher-taught model but will fail immediately the problem requires any variation from this standard technique. The nature of the responses will follow the SOLO pattern outlined above for mathematical systems in general.

(b) Working within Simple and Complex Systems

Lunzer (1973) distinguishes between simple and complex systems; simple systems are those where any solutions required can be found by looking at

one set of co-variations; complex systems are those where more than one system of co-variation is involved and any meaningful solution of a set problem depends on the interaction of the two (or more) systems. For example problems involving the use of the formula for the area of a rectangle can be formulated at either level. Children responding at the relational level indicate that they can work effectively with a formula at a certain level (Collis, 1974). They are able to recognise that, given any rectangle with specific units which measure "L" and "B" they are able to find "A". There are clearly a large number of possible rectangles and consequent "A's", but they are able to work with the concept because it is, for them, essentially a single system of co-variation, i.e. the area changes as the rectangle changes, or "L x B" changes as the rectangle changes. What they cannot do is relate changes in one or more of the variables "A", "L" and "B" to changes in one or more of the others. For example, they would not be able to solve problems of the kind, "A" is to stay constant and "B" is to be changed in some way (doubling etc.), what must be done to the length "L"? This type of problem involves the child in working with the interaction between two systems. "B" is varied and "L" must be varied in a compensatory way in order to keep the product, "L x B", constant. It is not until the student can respond at the extended abstract level that this type of problem representing a complex system can be handled.

From both experimental evidence and classroom experience it seems that the level of tolerance of lack of closure which the individual has available largely determines the complexity of the system within which work can be done meaningfully. It is not until students are responding at the extended abstract level that closure is seen as simply a mathematical property. At this level they can work meaningfully without closing operations and thus have the ability to handle multiple interacting systems where it is necessary, not to obtain a unique result, but to consider the various possibilities that result from the interaction of two or more simple systems before drawing a final conclusion.

A good illustration of the difference in levels of thinking demonstrated by students responding at the relational and extended abstract levels is provided by the following sequence of exercises. Students responding at the extended abstract level can use their ability to recognize and handle multiple interacting systems to reduce their working considerably.

"Do the following series of exercises in the order given, keeping the working for each one as it is completed:

Given $V = \pi r^2 h$,

(1) Find V, given $\pi = \frac{22}{7}$, $r = 2$, $h = 7$.

(2) Find V, given π = same as in (1), r = same as in (1), h = double what it was in (1).

(3) Find V, given π = same as in (1), r = half of what it is in (1), h = same as in (1).

(4) Find h, given V = same as in (1), π = same as in (1), r = half of what it is in (1)."

In general, students responding at the relational level treat each exercise as completely independent. They work out the new dimensions and substitute in the formula without realizing the significance of their first result in relation to the change in one dimension of the formula. If prompted after the second exercise some will agree that one could have expected the second answer to be double the first but most would still go through the substituting and calculating "to be certain". At this level the children seem to be unable to relate changes in one or more of the variables in a formula to changes in one or more of the others. It is not until responses are made at the extended abstract level that one notices that the student immediately realizes the usefulness of the first calculation for determining the second answer.

In terms of SOLO description there is little point in trying to distinguish response levels below multi-structural with this type of problem. In fact even a multi-structural response is difficult to separate from a relational response.

Multi-structural Responses

Responses at this level treat each part of the problem quite independently and even prompting does not move the child to see that one could have any expectations about one part of the exercise on the basis of previous results. Each calculation is worked out in full and a closure is made.

Relational Responses

Initially responses of this type appear to be multi-structural but the difference lies in the fact that the respondent will see the significance of the relationship between the items if prompted. However, he will not be willing to base decisions entirely on this knowledge but will wish to work out the calculations to satisfy himself that his "hunch" is true.

Extended Abstract Responses

The extended abstract response involves an immediate awareness of the reliability of the relationships between the various items and a confident utilisation of this fact to give correct responses without carrying out extensive calculations. If asked to justify his answer to later items he will give the logic of his decisions without recourse to working out each individual item as concrete proof.

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EXAMPLES OF THE TAXONOMY IN USE

3. ENGLISH

SECTION C: Examples of the Taxonomy in Use

3. English

The teaching of English includes many topics and activities and it will not be possible to look at all of them here. We shall choose three areas in which we have done some SOLO analysis to illustrate the general approach, and the reader may generalise to other areas if he so wishes. The areas chosen involve, (1) content analysis (appreciation of poetry) and (2) process analyses (reading; creative writing).

(1) Appreciation of Poetry

A fairly common task in upper primary and high school is to ask the student for an oral or written appreciation of a poem. In our own case, we followed the procedure used by Mason (1974) who, after presenting the poem, simply asked the question: "What does this poem mean to you?" The response to that question can incorporate none, one, or several, of the following features: the various literal and metaphorical meanings inherent in the poem; the rhyme, rhythm or other structural features or techniques used by the poet; the integration of cognitive or intellectual with affective or feeling aspects; and so on. The presence or absence of one of these features was then used to judge SOLO levels according to the following criteria:

1. Prestructural

No answer; a virtually complete lack of understanding of what the poet is saying; an irrelevant answer incorporating none of the above features.

1A. Reaching towards an understanding of one feature.

2. Uni-structural

One relevant structural feature such as a comment on rhyme; a concrete point made by the poet; a slab of verbatim repetition from the poem involving no interpretation of the passage quoted (this last type of response involves a unidimensional strategy and hence is coded as uni-structural).

2A. Two points involving contradiction but no resolution of the contradiction; a direct quotation with some interpretation.

3. Multi-structural

Several concrete points supportive of one fairly liberal interpretation; one or more substantive points together with a comment on

a structural aspect of the poem; a paraphrase of the poem involving substantial interpretation of independent points.

3A. A list of concrete points, and an attempt at constructing an interpretative framework but which is incomplete or contradictory.

4. Relational

A coherent framework for interpreting most or all of the poem, but which is limited to the context set by the poet and the firm notion that the poet meant this and nothing else.

4A. An attempt to make an abstract generalisation but is hesitant, inconsistent, or incomplete.

5. Extended Abstract

Sees the poet as making universal statements by using the poem as a medium; allows alternative explanations of the poem; appeals to abstract structures not necessarily inherent in the text.

The first example was given to Year 9 students:

1. To a Child Dancing in the Wind

Dance there upon the shore;
What need have you to care
For wind or water's roar?
And tumble out your hair
That the salt drops have wet;
Being young you have not known
The fool's triumph, nor yet
Love lost as soon as won,
Nor the best labourer dead
And all the sheaves to bind.
What need have you to dread
The monstrous crying of the wind?

William Butler Yeats

1. Pre-structural

"To me it is a bunch of words which don't mean anything."

This response speaks for itself; there is no attempt to grapple with the question.

1A. "I don't really know what this poem is about because I don't understand it. But it is something about the life of a child. It isn't a very good poem because it isn't very descriptive enough. The poet has tried to confuse by putting question marks."

This is a good response for a 1A level as the student is obviously struggling hard to make sense of not only the words but the structure (the notion that poems should be descriptive, and the comment on the use of question marks). Nevertheless, he seems to have missed the point on all of his potential grounds of analysis.

2. Uni-structural

> "To me To a Child Dancing in the Wind means a child dancing and moving along with the wind. Moving in graceful steps in the direction of the wind for the wind moves slowly. The child is in the middle and wind is turning her around."

This response begins with pure tautology (which would make it Level 1) but then moves onto and expands one point the poet was making.

2A. "It means to me that the girl is happy about something and then she is sad as if no one cares."

This student has extracted two ideas the poet could have been discussing - happiness and sadness - but doesn't reconcile them or interpret them.

3. Multi-structural

> "I think the poem is about a child of the sea because even if the waves are large they will not harm the child. The child dances on the shore and doesn't care about the water's roaring. The child lets down its hair so it will dry out the salt water spray. The child is young and doesn't know about losing someone's love as soon as you learn to love them, and that the best worker dead when all the work has not been done yet. And all you need to fear is the crying of the dreaded wind."

This student has made a conclusion ("the poem is about a child of the sea"), and then quotes selectively and fairly literally to back up this point. At first sight it reads like a higher level response, but the selection of words is very concrete and close to what the poet himself wrote.

3A. "I don't think the author can see that a child does need to care about Life, and maybe just because the child is young it doesn't mean that it doesn't know that 'fools triumph' or that the child hasn't known 'love to be lost as soon as it was won'. It would depend upon what sort of background the child has had and how it sees the world through its own eyes. The lines 'what need have you to dread the monstrous crying of the wind' are a bad question, e.g. What if the child has no home or shelter or is a long way from its home when the wind comes?"

This response shows a mixture of abstract, egocentric thinking (the poet failing to see the child's world) and a literal concreteness which rather

spoils the effect (what if the child has no home?) so that while the respondent is straining towards an integrated, even an extended abstract response, the point is missed or is not developed.

4. Relational

> "The child dancing in the wind doesn't have any meaning to me except it has a natural carefree atmosphere when you read it. The child is free of worries and doesn't understand the ills of the world. Being too young to have any fears or hangups of any kind, e.g. 'The fools triumph, nor yet
> Love lost as soon as won'.
> The last few lines then talk about growing up and what you have to look forward to in the future - the worries and responsibilities
> 'What need have you to dread
> the monstrous crying of the wind'."

The last half of this response contradicts the opening remark: this student clearly does perceive a coherent and generalized meaning in the poem, namely a concern with youth and carefreeness on the one hand and maturity and responsibility on the other. The message is however sparsely presented and this constitutes a minimal Level 4.

4A. "The poet is saying that children should have no cares for anything. He says they should take things for granted whilst they are young because responsibilities become overladen when people become older. He thinks that children should enjoy themselves before they have to know about love, employment and life in general.

> The Child Dancing on the open beach symbolizes the expanse of life spreading before her, yet she seems to want to meander slowly, signifying the slow growing and maturity of the girl. The monstrous crying of the wind shows the groaning of the world's problems, problems the girl will not have to worry about for a long time."

This response expands and generalizes the message of the previous response. This one is in fact verging on Level 5, but a close reading seems to make it clear that the respondent is staying within the context of the poem itself: Despite some suggestions to the contrary ("He thinks that children should enjoy themselves ...", "the groaning of the world's problems") the respondent returns firmly to "the girl" and makes a firm closed interpretation within that context.

2. The Man in the Ocelot Suit

Our neighbour's dog ate
Our paper. My wife
Complained. They said get up
Earlier, go to work,

What do you do all night?
My wife said
We think grave thoughts, and laugh
Against Establishments.

The dog kept eating the paper,
So I rented
An ocelot suit and sprang
Out of a ditch. The terrified

Dog never came back,
But our neighbours
Came, breathing hard, and ate
The paper themselves to set

Us straight and make the world
Safe from crackpots,
Now I loaf in my sleek
Ocelot suit, amusing the children.

When it is night,
I leap into our neighbour's
Roof and devour their dreams.

Christopher Brookhouse

Two sets of responses are given at each level. The first set, (a), were obtained from Year 9 high school students; the second set, (b), from university undergraduates attending evening classes, most of whom were mature age school teachers. By comparing the (a) and (b) responses within levels it is possible to compare and see how adult and young adolescent responses differ, apart from their structural identity.

1. Pre-structural

(a) "This poem is very hard to understand and makes no sense to me whatever."

(b) "A load of shit."

Both these responses avoid any interpretive or other comments about the poem. It is interesting nevertheless that the child's response is appreciably more sophisticated than the teacher's.

1A (a) "I don't understand this poem. It doesn't make sense, this makes it humorous."

(b) "None observed."

The student's response shows an attempt to make something of the lack of sense which makes it clearly superior to the previous ones, but falls short of a proper elaboration of the point.

2. Uni-structural

(a) "A dog who steals a paper. The people get upset, and set a trap to keep him away. They succeed. The dog doesn't come back. They are able now to reach it. Neighbours complain."

(b) "Life must contain some eccentricities."

(a) comprises a straightforward precis of the poem with no interpretation at all. (b) represents an interpretation at a moderately abstract level, but it is quite unidimensional, if not banal. Thus, while structurally similar, these responses are typically different: the child's is concrete and close to the given facts, while the adult's is more abstract, but still unidimensional in its way. It is worth noting that if the teacher had elaborated, giving support to her interpretation, the response would have been categorised as relational.

2A None observed.

3. Multi-structural

(a) "It is where people next door pinch the neighbour's paper and the owner catches the neighbour and stops them but the paper keeps disappearing. The people that take the paper don't work normally but entertain. He devours their dreams means that he wonders what he say in his or her dream."

(b) "The narrative isn't very clear. The two neighbours fight over the action of the dog and the aggrieved party gets his own back by frightening the dog. I think the writer is more interested in trying out a different style of writing poetry than telling a story."

These two responses are strikingly different but both are classified as multi-structural. The first paraphrases the narrative but also shows a considerable degree of interpretation, which although simplistic, attempts to make sense of particular passages. The second is really more concerned with structural aspects, narrative and style, than with making semantic sense from just the narrative aspect. The common element in both is the making of at least two independent points about the poem.

3A (a) None observed.

(b) "The Man in the Ocelot Suit means very little to me. It seems one man's imaginative dig at society. How one problem can lead to another - he gets rid of the dog, but creates an even bigger monster with the neighbours, then eating his paper - the last stanza we see him on their roofs devouring their dreams - wholly the poem seems like fantasy."

This response shows an attempt to create an interpretive structure but in both the opening and closing remarks, the respondent states that she is unable to reconcile the various points she has enumerated.

4. Relational

(a) "He doesn't like the rut that all the people he knows are falling into. He tries to be different. The dog always ate his paper so he scared it off, but everyone had their papers eaten by the dog so his neighbours thought it unfair that his papers didn't get eaten so they ate it themselves. The children thought he was funny but everyone else thought he was mad."

(b) "The man feels he is being criticized by the neighbours. The dog from next door eats his newspaper and his wife complains about it. His neighbours pressure him by telling him he should get up earlier, then maybe the dog won't eat the newspaper.

The man feeling pressurized into getting his revenge, scares the dog - he never returns, yet the man can't escape from being victimized - the neighbours eventually eat the paper themselves.

The neighbours represent a world of frustration - the man is frustrated with his neighbours evident in his action when at night he torments and harasses them. The neighbour's world is alien to his - they laugh at establishments and thus don't conform to social norms. The man can't understand this - he lives in a world where your neighbours oblige you by stopping their dog from eating the newspaper. He resents being down trodden, and at last does something about it."

Both these responses give a coherent and logical explanation of the action. The (a) response uses the simple concept of those-in-a-rut and those-afraid-of-falling-into-a-rut; the second a rather more generalised relating concept of frustration and conformity. The (b) response is more sophisticated but interestingly distorts certain data in that the neighbours are seen to be the nonconformists.

4A (a) "This poem is a nonsense poem. It's not prolific, it's not going to change the world's present way of thinking; its just there to amuse us. The poem is about a man who doesn't get on very well with his neighbours because the neighbours' dog eats his newspaper. But the real reason this man can't get on with his neighbours is because he can't understand their way of thinking. So to solve the problem of the dog he hires an ocelot suit and scares the dog away but makes his neighbours angry. The neighbours think he is a nuisance and a crackpot. And he probably is. I think the poem is rubbish and really doesn't make much sense but the author did intend it to be that way. Some people probably find it amusing but it just doesn't appeal to me. I think what the author is trying to say is that you may think other people crazy but just look at yourself for a while."

(b) "At the beginning the picture conveyed is that of a society oppressed person. 'Go to work' symbolises restriction of any kind of freedom (in the sense that self-development

can not be reached) the freedom of doing what one wants to do. The wife symbolises the responsibility, and the 'horrible thoughts' and 'might' create a scene of desolation and helpless existence. Buying a suit symbolises the undermining of this kind of social scene. As a result the man is crushed by the neighbours who come to eat the paper not only before it was only a dog (external force), now it is the internal force within him that makes him even more miserable. His failure is represented by the use he makes of this Ocelot Suit - to scare children. Children represent the passive internal state of the poem (innocence destroyed? altered)."

Both responses attempt an abstract interpretation but in neither case does it really come off. The first seems to be dismissing the poem, yet the respondent keeps coming back with both structural and content interpretations of a high level of generality. The first sentence "This poem is a nonsense poem" is almost certainly a firm closure about the poet's intentions, rather than as might appear, an inability of the reader to make sense of the poem. The second response is clearly a "failed" extended abstract. The respondent has tried to generalise from several aspects of the poem to a universal scale, but the result is inconsistent, incorrect (e.g. using the suit to scare children), and loosely conceptualised.

5. Extended Abstract

(a) None observed.

(b) "The Man in the Ocelot Suit represents a man escaping from the social presures of the day. In dressing up he hides his real personality and is able to cope with the problems of everyday life (that is, the dog) but he cannot escape the people in his life who continue to plague. To cope with this problem he lives on the fantasies created by others, perhaps signifying television, books, radio etc. The children can laugh at his disguise for they see it with naive eyes.

The fact that he 'loafs' can be seen as an indication of the sterility and laziness of modern life. The line 'We think grave thoughts and laugh against the establishments' could be a derogatory comment on the establishments today, that is the governments, multinational companies, etc."

This is not a very good example of an extended abstract response, but this poem elicited very few responses at this level (better examples to different poems are given below). Nevertheless, the respondent is trying hard to generalise about life and employs symbolism that is not given in the text (references to mass media, multinationals, etc.). The poem is clearly interpreted as being more about abstractions such as the dynamics of modern living as a whole, than as a series of symbols tied to particular aspects of the poem or the action.

3. Hawk Roosting

I sit in the top of the wood, my eyes closed,
inaction, no falsifying dream
Between my hooked head and hooked feet
Or in sleep rehearse perfect kills and eat.

The convenience of the high trees!
The air's buoyancy and the sun's ray
Are of advantage to me;
And the earth's face: upward for my inspection.

My feet are locked upon the rough bark.
It took the whole of Creation
To produce my foot, my each feather:
Now I hold Creation in my foot.

Or fly up, and revolve it all slowly -
I kill where I please because it is all mine.
There is no sophistry in my body:
My manners are tearing off heads -

The allotment of death.
For the one path of my flight is direct
Through the bones of the living.
No arguments assert my right:

The sun is behind me.
Nothing has changed since I began.
My eye has permitted no change.
I am going to keep things like this.

Ted Hughes

Responses to the third poem were made by a group of undergraduates, none of whom had read or studied the poem previously.

1. Pre-structural

None observed.

1A "This poem's pretty dumb really. It's about a hawk fast asleep at the top of a tree dreaming about what a great guy he is. No doubt he'll wake up to himself and find he'll have to work for his living like all other animals."

This response is classified as transitional pre-structural because the student has missed the point, possibly because he dislikes the poem, as he immediately admits. He has closed on a semi-relevant point (the hawk "sleeping") and carried on to make a private or egocentric point of the respondent's own, rather than the poet's. This response shows elements of both denial and transduction.

2. Uni-structural

"What this poem is saying is simple: I'm a hawk and I'm the greatest. We hawks are real terrors and everyone else had better watch it."

This student has grasped certainly one point in the poem, but has missed several others the poet was making.

2A None observed.

3. Multi-structural

> "The hawk hangs around in his tree either sleeping or resting. It is advantageous for take-offs and also to survey the land. He is a wonder of creation. He sits on it (and) or flys off - he kills if he likes because he owns the world. He has no manners - rips heads off.
>
> The hawk commands all and needs no justification - this is the way it has always been and always will be."

Again, this second response contains isolated aspects of the original descriptions of the hawk's activities (sleeping/resting, kills, rips heads off) and a repetition of the poet's interpretation (needs no justification, this is the way it has always been). This respondent has grasped certain aspects of the original poem, but not a general framework for it.

3A None observed.

4. Relational

> "The hawk is seen as omnipotent. Whether awake or sleeping he is the master of his world. On top of his tree, he can look down on everyone else and attack and kill them as he pleases; or when sleeping he practices the perfect kill in his dreams. When soaring in the sky, he simply reinforces his belief in his own omnipotence and power. He gets so carried away he comes to believe he created things like this and is determined to keep them his way. Actually he is in great shape to be a leader of the Liberal Party."

In this interpretation, the student has noted all the main points of the poem and has inter-related them into a consistent whole (the hawk as omnipotent). The last sentence, however, indicates elements of an extended abstract response (party politics are not given in the data), and might perhaps be more appropriately classified as 4A.

5. Extended Abstract

> (a) "This is a perspective of the world from an unfalsified position above and partially outside the world. But the hawk cannot escape the world he sees and needs for survival. The hawk is God inspecting his creation, determining death and making the world revolve at will. But it is an idealistic view of the world all the same. There are two directions he can go and he chooses a straight, idealistic one of stasis."

This respondent has gone beyond the given and has considered what might be: "There are two directions he can go" even though the poem only shows one, i.e. "stasis". The respondent has considered the poem in its entirety; if anything, the whole lacks some of the original detail. The statement "the hawk is God" is closed, but it is juxtaposed with the statement that the hawk depends upon the world for his survival, suggesting possibility and paradox.

(b) "Every aspect of creation has its purpose in life, and the hawk was born to kill.
Stanza 1: The hawk's life is controlled by one single purpose; he is nature's protagonist, confident in his role: 'I sit in the top of the wood, my eyes closed'. His is a commanding role and he allows no 'inaction, no falsifying dream' to interfere with his killing. Any dreams he may experience are rehearsals of 'perfect kills and eat'. He has developed his act of killing to a fine art for it is his means of survival, and further helps to maintain the natural balance of power.
Stanza 2: His necessary position in the natural world is aided by nature: 'The convenience of high trees. The air's buoyancy and the sun's rays are of advantage to me'. The earth is his prey and 'faces upward for my inspection'.
Stanza 3: The hawk then, is the instrument of death, his mission being to kill life. Creation produced his 'foot, my each feather'. In turn, he asserts his individual manipulation of nature. 'Now I hold Creation in my foot'. It appears then, that the link between life and death is that creation creates life to be the victim of death, in order to maintain the natural order of things.
Stanza 4: The hawk is central to the life-death process, hence his arrogant assertion of superiority 'I kill where I please because it is all mine'.
Stanza 5: The hawk is free in his 'allotment of death'. His path is directly 'through the bones of the living'.
Stanza 6: The act of killing life is now applied to the infinity of time, past present and future, I am going to keep things like this.' Death is a necessary phenomenon, and life is the instrument by which its state is achieved. The hawk is the weapon used by the death process."

This lengthy response illustrates several features of the extended abstract response: systematic accumulation of evidence and cumulative abstraction of hypotheses, in this case ending with a fairly closed interpretation. For example, "the hawk then is the instrument of death" and "it appears, then, that the link between life and death is that creation creates life to be the victim of death in order to maintain the natural order of things". The "then" expressed in both these statements suggests that the conclusion was reached only after careful consideration of the presented data, so that the eventual closure ("the hawk is the weapon used by the death process") follows almost deductively.

4. Spring and Fall - to a young child

Margaret, are you grieving
Over Goldengrove unleaving?
Leaves like the things of man, you
With your fresh thoughts care for, can you?
Ah! as the heart grows older
It will come to such sights colder
By and by, nor spare a sigh
Through worlds of wanwood leafmeal lie;
And yet you will weep and know why.
Now no matter, child, the name:
Sorrow's springs are the same.
Nor mouth had, no nor mind, expressed
What heart heard of, ghost guessed
It is the blight man was born for,
It is Margaret you mourn for.

Gerard Manley Hopkins

The five respondents were all undergraduates, and this time some relevant background information was available for each respondent.

1. Pre-structural

None observed.

2. Uni-structural

None observed.

3. Multi-structural

Subject No. 1: Age 21, music student, does not like poetry, last studied poetry at high school, has both read and studied this poem.

> "This poem tells of a girl grieving over dead leaves. The poet says the girl will experience a lot sadder things as she gets older. Life has to end sometime and so Margaret associates the dead leaves with her own termination."

This response is limited by not generalising beyond the character in the poem, which indicates this subject has ignored some data in the poem, and has missed their inter-relationship. He is therefore limiting himself to isolated elements which are not integrated ("grieving over dead leaves", "will experience a lot sadder things", "Margaret associates ...").

4. Relational

Subject No. 2: Age 23, Dip. Ed. (Maths) student, likes poetry, last studied poetry at high school.

> "Someone is telling the child not to worry about Goldengrove losing its leaves, and is perhaps sceptical that the child can care for them so much. When you get older you will not give them a thought. Yet you will weep, and its for yourself because in the death of those objects you recognise your eventual death."

Most of the points the poet has made have been accounted for here, and the respondent has linked them into a comprehensive explanation. Nevertheless, this response is very much tied to the original context (especially this is seen in that both the explanation and the poem begin and end at the same points).

Subject No. 3: Age 20, Arts III, does not like poetry but last studied poetry in third year University, has read and studied this poem.

> "The author is speaking to a young child who is weeping about the leaves falling from the trees in fall. He explains that as she gets older these things won't be important to her at all. Adults don't appear to have the same sensitivity as children. The child isn't really sure of why she is crying; the author knows and tells her that she will know one day too. Life is full of sorrows and the sorrow Margaret feels during the fall is only the beginning. The sorrow is really for herself."

This response shows a high degree of interpretation using the relating concepts "Adults don't appear to have the same sensitivity as children" and "Life is full of sorrows". However, the response is still bound by the context, and there is no indication that the student entertained alternative interpretations.

5. Extended Abstract

Subject No. 4: Age 21, Arts III, likes poetry, studied poetry at third year University, has both read and studied this poem.

> "This shows the innocence of youth and the young and fresh approach thus known but proceeds to exhibit how experience of life makes fresh ideas distant and inaccessible. As Margaret ages, following the cyclic pattern of nature, she realises why she is weeping about things and the inevitable disappointments life brings. But she had known of these things in her heart all along, not knowing how to account for them although they were instinctively known.
>
> Man is born for unhappiness and spoiling, especially spoiling through age, and self-pity gradually shows itself."

The respondent has abstracted universal principles from the context (see the last paragraph and "experience of life makes fresh ideas distant"). He responds to the poem as a whole, not to specific lines: the total impact is reacted to emotionally, with a strong integration of interpretation with effect. The principles and effective overtones produce the decision in the last paragraph, which has a generality and appeal of its own, although usually extended abstract responses withhold closure.

Subject No. 5: Age 21, Arts III, likes poetry, studied poetry at third year University. Has both read and studied this poem.

> "In this poem, Hopkins presents a study of youthful innocence and its growth towards acceptance of human mortality. In writing this poem Hopkins is inspired by the sight of the innocent Margaret, grieving over the fallen leaves of autumn. The worlds of man and nature are allied in this poem in that they both relate to the cyclic process of birth and death. Margaret's 'fresh thoughts' are of innocent love for all things, for she is not yet affected by the knowledge of experience.
>
> At this point Hopkins intervenes - he introduces the facts of life and death, because 'as the heart grows older' she will understand the inevitability of death. The coined words 'wanwood leafmeal' evoke the image of leaves lying pale or mealy on the ground as the woods lose their green innocence in the autumn gloom of approaching death. This image is a parody of the ultimate state of man. Hopkins relieves the child's despair when he says: 'Sorrow's springs are the same' - sorrow's source is universal for it springs from the knowledge of death.
>
> The point of hope and relief in this poem is the knowledge of life after death a phenomenon expressed by the Holy Ghost to man. This knowledge of everlasting life is not consciously articulated: 'Nor mouth had, no nor mind expressed', yet it is inherently present within man's heart.
>
> Finally Margaret learns 'the blight man was born for', the destiny of man is associated with the falling leaves; both are born to death. Acceptance of death is necessary for it is a natural phenomenon of life. Margaret becomes the self spirit, in fact weeping for her own mortality."

The respondent sets up abstract hypotheses based on the data (e.g. alliance of man and nature in cyclic processes - the "state of man" can be seen in nature). Her response is not closed as would appear at first, although she seems to have decided that the meaning of the poem is the "acceptance of human mortality". She has introduced the idea of "life after death", which reopens the question of mortality.

It is interesting to correlate the biographical data with the level of response, given the very small number of subjects, because they give a hint of what is required to produce a high level SOLO. Possibly the strongest factor to emerge, given that all were mature, highly intelligent subjects, is the affective commitment to the medium of poetry in general and the willingness to become involved in the task poem in particular. Thus, it should be noted that both extended abstract responses were from students who had studied poetry to third year, liked poetry, and had previously studied this particular poem. Interestingly, the multi-structural response came from a student who had indeed studied this poem before, but who did

not like poetry. These observations are important in setting the teacher's expectations for his students' performance level.

Implications for Teaching of Poetry

Teaching implications may be derived from the three areas of Curriculum, Evaluation and Teaching Method mentioned in Section B, but perhaps more than in other subjects, these aspects are more closely integrated in poetry appreciation.

As far as curriculum is concerned, the teacher would first need to decide what parameters in poetry appreciation would be expected from students - such as imagery, rhythm, rhyme, parts of speech, etc - as well as what substantive points the poet might be making in a specific poem. There is then both a specific and a general analysis to be done. The general analyses are fairly clear cut - it is only a matter of deciding, for example, whether or not verse form is to be taught or not, or whether a precise analysis of metre and rhyming patterns is to be made - whereas specific analyses are much more subjective, difficult and open to widely differing interpretations.

One aspect which makes SOLO analysis in poetry at least different from that in other subjects is the question of affective reactions. It is arguable that the affective impact of a poem is the most important feature of it, and that any cognitive judgments come second, being constructed upon the primary affective foundation.

An example might make this clearer. In one seminar in which the SOLO analysis of poetry was being discussed, two poems were given to the participants, one of whom was a professor of Education with an interest in poetry. Within ten minutes he had ranged from a pre-structural response to a haiku ("Don't like it; don't understand it!") to an extremely well-worked out extended abstract response to a Stevie Smith poem. The difference was simply due to his lack of interest in one poem and his intense interest in the other. While such affective involvement in the task applies to all school learning, it is probably most critical in the area of literary appreciation: hence high level SOLOs take on a more emotive character here than they do, say, in history. We also saw something like this in the last poem reviewed above.

Nevertheless, literary appreciation is not just a matter of quietly emoting within oneself. The point of the exercise is to externalise and express clearly to others what the poem or novel is about, so that they too can share in, or at least empathise with, that affective reaction. This communication process is more effective with higher than with lower level

SOLOs; as was seen, any affective response from the reader was called out only in the cases of the relational to some extent, and in the extended abstract to any major extent. This raises the interesting question as to the possibility that improving SOLO quality might likewise deepen affective responses; or whether only high level SOLOs can be obtained when there is already a deep affective response. We have no evidence on this point, but it would seem that, in either event, raising SOLO levels is here as in any other subject, a good aim per se. A strategy for raising SOLO level is the Plus One, mentioned in Section B.

Thus, if a student gave a uni-structural response, say to "Hawk Roosting", he could be shown how he could have included other aspects of the poem, converting his uni-structural into a multi-structural response. However, possibly it would not be advisable to trace out a relational interpretation with him, i.e. two levels up from his existing one, because it may not be within the cognitive reach of the student to keep several independent aspects of the poem in mind, and then inter-relate them such that, for example, they all point to the conclusion that the hawk is omnipotent (see p. 124). The success or not of such "teaching-up" strategies will depend inter alia upon the stage of cognitive development of the student. It will obviously be easier to discuss abstract principles the poet might have been referring to with intelligent and sophisticated adults than with young children. As we have noted, interest is a key factor in the massive "under-achievement" in adults' responses (especially) to literature, whereas with younger, less mature students the low levels of response is more likely to be due to the limits imposed by development.

To sum up, the most important contribution of SOLO analysis to literary appreciation is that it really requires the teacher to ask himself what, in general, he is hoping to achieve by teaching poetry - the techniques of writing, the structure of various verse forms, the appreciation of imagery and various parts of speech, the cultivation of an emotional response as pre-eminent, gleaning the poet's philosophy of life, the illustration of various literary and historical styles, and so on. When these aims have been clarified in general terms, then it becomes possible to choose the particular item - poem or other literary passage - and analyse the specific translation of these aspects into terms specific to the poem.

(2) Reading

Some work has been done in applying SOLO analysis to the teaching of reading in the primary school. Reading is a process skill, and given a

basic oral fluency in the language, there remain two major generic processes in reading: word attack and comprehension, with other subprocesses of lesser importance. We have concentrated here only upon word attack skills, in two studies, and they begin only to scratch the surface of the problem. They are included here to give an indication of the application of SOLO to this area, rather than to provide definitive answers to problems in the teaching of early reading.

The St Lucia Graded Word Reading Test (Andrews, 1969) provides a check-list of word attack skills, which are noted, in individual administrations of the test, as skills are applied by the testee to a list of 100 words of increasing difficulty. The test allows for the following word attack skills:

(i) visual approach
(ii) phonic analysis
(iii) structural analysis
(iv) guessing from salient parts of the word
(v) spelling approach
(vi) no consistent method.

The test is scored by noting (a) the number of words out of 100 that are correctly identified, and (b) the frequency of use of the skills listed, with qualitative notes on their appropriateness. It is important to realise that there is no single all-purpose word attack strategy; much depends upon the novelty of the word to the student, its conformity or not with the more important phonetic rules, and also upon the methods of attack emphasized in teaching method.

According to SOLO theory, respondents to the St Lucia Test could be categorised as follows:

1. Pre-structural No consistent use made of any strategy; closure follows upon the first method the subject hits upon. While different strategies might be used over the whole list, only one method is used for each word: if the particular strategy did not work for a particular word, the student would not try the same word with a new strategy but would move on to a new word (either with the same or a different strategy).

2. Uni-structural Consistent use of one word attack strategy, irrespective of its appropriateness to the particular word. For example, a pupil might rely heavily upon phonic analysis, and when this does not work, as it certainly will not in many cases, the pupil will revert to guessing or give up. As in pre-structural word attack, closure is here very high.

3. Multi-structural Use of several word attack strategies but independently of each other. The student would be able to use visual recognition, phonics, spelling, guessing from salient parts, etc. but would deploy these strategies one after the other, not using the information from one to help in attacking a new and difficult word with a different strategy.

4. Relational Use is made of the fact that each strategy has its own advantages and disadvantages given the nature of the new word and the student's own knowledge. Closure can be withheld until the best fit is obtained; hence word attack is carried out selectively. This approach was not however used by any students in the present sample.

5. Extended Abstract Not observed in the groups tested. This level is unlikely to be relevant to the teaching of reading as such but would possibly involve the kind of hypothesis testing used by foreign language students in deducing the correct meaning of a word or passage which he has not seen before.

Table 2 summarises the salient data for a group of five subjects, selected from test results obtained from an unstreamed class of 19 Year 4 pupils.

Table 2: SOLO Levels in Word Attack Skills

	Subjects				
Strategy	1	2	3	4	5
visual approach			**	*	*
phonic analysis		**		**	**
structural analysis	*			**	
guesses from salient parts	**	*			*
spelling approach	**				* (for new words)
no consistent method					
No. Correct	23	67	49	56	79
IQ	80	100	95	100	125
Age	9:0	9:1	9:0	9:6	9:5
SOLO level	P.S.	U.S.	U.S.	M.S.	M.S.

* = significant use of strategy
** = a great deal of use of strategy

Pre-structural

Subject 1 was in a remedial group: as can be seen, he has no consistent pattern of responding. Each word was considered only once, and even if he knew he was going to be wrong, he would not try again with a different strategy (which is what separates the pre-structural response from multi-structural; the profiles look similar, but in the first case the strategies are deployed in ignorance).

Uni-structural

Subject 2 relied heavily upon phonic analysis and when this did not work, she would have a random guess, then give up. Interestingly, however, it is to be noted that she was pretty successful at phonic analyses, obtaining the relatively high score of 67 correct words.

Subject 3 used a much less successful approach, based on visual recognition. If he did not recognize a word immediately, so that he could read it without going into word analysis, he simply ignored it and continued through the list until he came upon one he did know. Closure was very high, and prevented this student from acquiring and using a wider range of word attack strategies.

The fact that Subject 2 relies heavily on phonics and Subject 3 on a visual approach possibly reflects a difference in previous experience, specifically with respect to teaching methods emphasized. Unfortunately, there were insufficient data on the present subjects to clarify this point, but the question is addressed in the second study.

Multi-structural

Subject 4 was very persistent, trying several strategies (up to eight attempts per word) until he thought the word sounded right. He would use structural analysis, then phonic analysis, then guessing from salient parts, then spelling (not necessarily in this order) until he was satisfied. As his score indicates, he was not as successful as his persistence would suggest, doing less well in fact than Subject 2's sole reliance on phonics. Subject 4 did not use information across attempts; each attempt was a completely novel assault on the word.

Subject 5 had a similar strategy to Subject 4, but was much more successful. He had a relatively high degree of success with new words, trying each word with each of the strategies, whether or not they were satisfactory. For example, a spelling approach to "sabre" did not produce the correct sound, and he knew it, but he did not return to phonic analysis to help him out, having already used and discarded the latter.

These data suggest some interesting observations. Although we were not able to obtain examples of higher levels in this group, there is still a great deal of difference in approach to word attack that is not captured by other analyses of the data (e.g. number right, or error analysis). Thus, although there is a general correlation between number right and SOLO, there is the interesting example of Subject 2's relatively successful but less sophisticated approach compared to Subject 4's more flexible but to date less accurate deployment of word attack skills.

A related issue here is that of teaching method. While children tend to generate their own word attack strategies in due course, whatever the predominant method, it seems possible that emphasis upon either whole word or phonic methods could to some extent fixate a child at the uni-structural level. For example, one might expect to find that Subject 2 had been exposed primarily to phonic methods and Subject 3 to whole word methods. A flexible approach would tend, on this view, to lead to a more mature level, even if this was at the expense of short-term accuracy (cf. Subject 4). Unfortunately, however, the appropriate information was not available and a second study was carried out.

In the second study, 17 Year 5 students were administered the St Lucia test, which was scored, as before, for number of words correctly identified, and for frequency of use of the various word attack skills. In addition, IQ was available, and for eight subjects, their teachers were interviewed concerning teaching methods used in the early approach to reading.

The general pattern of results was as follows:

Table 3: Results for 17 Year 5 Students on Word Attack

	N	No. Correct	Mean IQ
Pre-structural	3	32.3	75.7
Uni-structural	6	39.8	90.2
Multi-structural	8	82.0	116.9

There is clearly a very strong relationship here between SOLO level, number correctly identified, and IQ, but on the data available and with the small number of subjects it is not possible to trace any causal links. It is simply to be noted that, not surprisingly, brighter children tended to give higher SOLOs and to get more words correct.

The results of three uni-structural students are of particular interest with respect to teaching method: one student used exclusively phonic methods of word attack, and two students used visual methods. Interviews with their teachers revealed, however, that all three students had had the same teachers from Year 1, and that the method of teaching had been eclectic. Further, three multi-structural students had been taught by these same teachers. These data suggest, then, that the beginning reader grasps one strategy, which then becomes firmly established, and this determines how subsequent information provided by the teacher is read in, at least perhaps until subsequent cognitive development allows "room" for multiple strategies. Certainly the strong association between IQ and successful deployment of multiple strategies suggests that teaching method as such may not after all be crucial in determining a uni-structural fixation on a particular strategy.

This point needs some further consideration. It will be recalled from Section A that limitations exist in working memory (p.15), and further, that these limitations may be due to lack of experience in the particular item occupying working memory at the moment. Applying this to reading, it seems likely, in the face of the present evidence, that the young student does not have the capacity in working memory to handle more than one strategy of word attack at a time. Thus, although the teacher might be emphasising several ways of handling a word, as indeed is currently fashionable in eclectic methods of teaching, much of this effort in the early years may be a waste of time. It would seem that more benefit would accrue to the child from the teacher's first emphasising one method, and allowing the child the opportunity of automatising that method; then extending his repertoire to other methods; and finally orchestrating them into a systematic meta-strategy. Smith (1971) likewise suggests that eclectic methods may not result in the parallel development of multiple reading strategies, while Jackson (1972) found that children who had been taught only by the phonics method were superior readers to those who had been taught by several methods, or eclectically.

An efficient teaching strategy would therefore seem to involve teaching one word attack skill first - and the evidence would probably favour phonic analysis - and then, when that is well automatised, the child can handle further strategies, with increasing understanding of their particular advantages for different kinds of words as he progresses. Nevertheless, it would be inappropriate here to go into early teaching reading in detail, except to point out the evident value of SOLO as an analytical tool in this area, as well as being able to provide formative evaluation for teaching purposes.

(3) Creative Writing

One of the common school tasks is creative writing, i.e. where the writer addresses an audience, in his own words, but not necessarily on a topic of his own choosing. Despite the open-ended nature of this task, it is possible to note a common structure and common components, which makes it amenable to evaluation in terms of the SOLO Taxonomy.

A perceptive analysis of creative writing in schools is that by Britton, Burgess, Martin, McLeod and Rosen (1975) who analysed several hundred examples of the written language of 11 to 18 year olds in Britain. They used the function of the writing as their major point of departure. Mature writing has three main functions: transactional, expressive and poetic. Transactional writing requires most participation from the reader; programmed instruction, a text book, a set of directions to follow, would be examples. Poetic writing requires least participation, in Britton's view, in that a poem is an "object made out of language. The words themselves, and all they refer to, are selected to make an arrangement, a formal pattern". (Britton et al, 1975, p. 90). Expressive writing falls between poetic and transactional: it requires some participation from the reader. Expressive writing is closer to "thinking aloud on paper" and is usually for this reason the most personal and revealing.

Expressive writing is the most common variety, and occurs the earliest; indeed the learner-writer begins to write in the expressive mode. It is only with the beginning of formal operations that the child begins to write successfully in transactional or poetic modes. We would thus expect to find that the lower SOLO levels are not represented in the transactional and poetic writing.

For our purposes, however, the most important feature arising out of the Britton analysis is that he drew attention to several components of good writing, whatever its mode, and to the apparent order of development, and to the interrelationships between these components. This is the kind of analysis which permits description in terms of SOLO levels.

Britton et al's components were used to help differentiate SOLO levels, and were modified progressively after several hundred examples of creative writing had been collected and analysed. The final criteria, with examples of each level and transitional stage, are given below.

1. Pre-structural

These responses are marked by a lack of an integrating or unifying theme beyond the writer's own perception. Such writing is entirely expres-

sive, but the use of language is restricted and related very much to the writer's own perspective, so that there is difficulty in communicating even basic facts about the event described. This writing usually lacks even a simple time sequence.

A Boating Holiday

> I was at the port and saw a raft with some kinds in it Dinki a captain in a tugboat Oceanliner with the crew waving a submarine surfising to the top a cook in a house boat and many many more in the ocean it was fabulos and went home to tell the news I did at the port on Sunday.
>
> Year 7

The student has a global image of his experiences at the port in his mind and from this he has written about the events as they occur to him. The composition is fragmented. He is unable to structure his composition or communicate his experiences in a logical sequence. The presentation of events is confused because the student is unable to free himself from his experience sufficiently to communicate the events and his thoughts to a reader.

1A. Transitional In high school it is rare to find creative writing that is totally lacking in structure; usually there is some single dimension that gives a modicum of structure in even the poorest essays. Often, however, such a dimension is poorly used, and the result is better classified as 1A transitional. The following are examples:

(1) Who I would most like to be

> I would like to be Roger Decocer because I love motor bike riding. I ride a YZ 125E and Roger decocer rides a RM360.
>
> Year 9

(2) What to Do on a hot Day

> on a hot Day I would normally go Down the Beach until it got cold and I would Be down their all Day. I wold Be riding a bourd or just Bone jaring or up the shop playing the pin Ball machines or perving on chicks.
>
> Year 9

(3) School and my teachers

> Im writing am essay on school and its teaches. The colass Im in is 7H and may roll coll room is Lab 2 and we go to get ore names maked of and for siens my favoret teacher is Mis Mecmolen she is how siens teochi. My langer teacher 2 are Mis Cove and Mrs Tarte. For English we have Mrs Luny. Gidenc in the Senory Study with The bepely head marster. Man and Sosiety with Mrs Darle and a lady but I have forgoten

her name Muzic we have Mis Capnen and we have the ather Muzic teacher for one piried a week. Ms Cilgorwer is my art teacher.

Year 7

(1) is a sparse example of a low level expressive structure: answering the question and supplying some backup and detail. (2) shows a rather more elaborated use of language and has an elemental chronological sequence. (3) attempts to differentiate personal feelings ("my favoret teacher") from what is otherwise a listing of facts: the very low level of grammatical skill also helps obscure the latent structure in this example.

2. Uni-structural

In essays at the uni-structural level, the writer attempts to order his composition logically. In the early stages the child does this by anchoring the events to a particular time, e.g. "It was in the May holidays"; "the next day"; "At 9 o'clock". Later in this stage he can construct a narrative composition even if he gives only a series of events linked by "and".

The events described tend to be based on the writer's own concrete experience, linked chronologically. There is little serious attempt to anticipate the reader's questions, or to deploy language with any intention other than to convey the facts; there is no use of language to create moods, for example:

(1) A Boating Holiday

We boarded the ship at 2 p.m. We leved about 9 o'clock everyone was sitting on the deck it was a nice night the stars were out. In the morning we played tabletenners we all swam we stop at the fist port which was singapore we stayed there for 3 days all the time we were there all we seme was by things eat. When we were liveing we got a big band playing on the port.

Year 8

In an attempt to give a chronological account of his holiday the writer anchors the events to particular times. In this way he is able to order the sequence of events for the reader. The content is determined by the events that were particularly striking for him; ("all we seme to do was by things eat") the events described are based solely on his actions and physical experiences.

(2) What to do on a really hot day

On hot days I love to go to the beach and hang around with all my crazy freinds. We usally go surfing and go swimming. I leave my board at my boyfriends place. Theses about 20 of us that go Maca Punce Jack Paul, Kad, Mark, Greg, Maria

Kim Tracy, Jane, Brad Lindsy Russel, Jeff, Scott, phill, Ken, Dave John. I go iceskating because on hot day's you can fall over and cool your-self off. When I go to the beach it's great to just sit their and get sunburnt and come back the next day and get sunburnt again then you go brown not red. After we get sick of the beach we pick up our stuff and jump into the panel vans and go for a rage around town. Just being mad then we go back to the beach after we get some food. We usually get hamburger or Heny-Peny. And some can's couple of dozen's because you really get thirsty. When I leave school I am going to be a beach bum for 3 months then I am going to get a job and just go to the beach on the weekends and after work.

Year 9

This example is quite long and detailed but the level is consistently uni-structural. Particular events are simply strung together - notwithstanding the last sentence, which raises a new aspect but deals with it peremptorily.

2A. Transitional An interesting contrast to the last essay is the following on the same topic:

(1) What to do on a really hot day

On a really hot I usally go to the beach. In the morning I awake at 6.0 clock take my red seda for a run then go for a early morning surf. It feels really great going surfing this early cause it kind of awakes me. After that I go home for a while have breakfast. Then I'm of to the beach again. But this time I go with all my friends we have untold fun. Sitting on the beach checking out the spunky guys. While were doing all this we usally come out of it with a really great tan.

By now its Lunch time, we all go down to the local shop and buy a hamburger. Then go back to the beach for a afternoon surf. We get ripped of a real lot because the guys don't like to see girl surfboard rides.

After my afternoon surf I go home and watch The young and the Ressless. Then if I'm going out I get ready, we all usally like to go to the local disco and Beach hotel for a rage.

Year 9

This is a distinct improvement on the last one, in that there is an attempt to express inner feelings ("It feels really great ... it kind of awakes me") as well as straight narrative of concrete events. However, it falls short of adequately developing this new dimension and so cannot be classified as multi-structural.

The next example is quite a different kind of 2A response:

(2) What the world would be like in two thousand

> In the year two thousand the world shouldn't be much different. Excepting may be that dope may be legalised wich you know it should its the same as booze in a fasion so i can't se the diffrense. The building will be diffrent as i figure it a hamburger will probably cost about two hundred dollars and the average man would have to be earning about 3000 to service and computers every wher inflation thats what starts and finishes the arguments the wont be any more poliyilion why not have a computer for a priminister over population everybody wil be fat? but then again who knows what the world is coming to do you?

This student has attempted a rather difficult projection into the future but is actually unable to decentre from his own concrete experience, hence his typically transitional inability to resolve the issue (which is not to be confused with an extended abstract lack of closure).

3. Multi-structural

The expressive function of language is exemplified in writing that not only makes statements or gives information but also reveals the writer's personal feelings about the statements or information. It uses loosely structured language that can be described as "thinking aloud on paper". This mode of writing allows the writer to relate his experiences in a concrete but logical way. The term 'concrete' is used to refer to the writer's dependence upon current or recently prior experience. His thinking and writing is therefore constrained in its logical implications by the particularity of this experience; there are no imagined possibilities or different observer perspectives.

The major characteristics in dimensions that could be expected at the multi-structural level are:

(i) well ordered events,
(ii) logically linked events that are based almost exclusively on the writer's concrete experience,
(iii) competent use of vocabulary and sentence structure,
(iv) a unified piece of writing staying within the field of concrete experience.

(1) My First Week at High School

> When the bus pulled to a steady halt near the school gates I alighted. This was my first day at high school and I was very nervous.

As Robbie and I walked through the school gate we received a terrible shock, when we compared the size of the high school to primary. A few minutes later we discovered that 40 teachers where teaching at high school but at primary we only had three teachers.

At 9 o'clock the hooter rang all students except the first year went to their classes. Mr. Copp depudy headmaster of the school told 1st where all the classes are. Later on that day we where put into our classes. I am glad to say I was put in 1B but I will have work hard or I might go down.

Now I have been going to high school for a week. In this little time I have decided that Science is my favourite subject. I like Science because I have never been in a Science room before ..... All put together I think high school is 100% better than primary.

Year 7

This is an example of the expressive function of language. The writing reveals a much greater competence in the use of vocabulary and structure than the uni-structural examples and although the central focus is still on the writer himself and his world, he attempts to make the events meaningful for the reader by describing his feelings, for example, "I am glad to say I was put in 1B". The events are logically linked and do not rely on one dimension (e.g. time) to tie them together, but it can be seen that the writing is virtually a record of the writer's concrete experiences.

(2) <u>What to do on a really hot day</u>

On a really hot day I would like to relax and go swimming, and sunbathing.

As I rolled over in my bed covers the bright sunlight struck my eyes. What a beautiful day I thought to myself as I slowly got out of bed. Today I would gather up some friends and head down to the wild surf and sandy beach.

When we arrived there the golden sand shone brightly expanding around the circular bay. We took our bags, beachtowels and radio and made our way through the sand to an little opening where the sun was above us, and also shade from a nearby tree. We put our towels down turned on the radio as we began to sunbake.

The sun was shining on the water making it glitter, boy was that a temtation. After about an hour and a half from lying in the sun we decided to take a swim. All four of us made our way down the glittering water. As our feet touched the water our sunburnt faces changed our facial expressions. The water was freezing, but we were so hot and red from the sun we didn't really mind.

We all waded out a little further and when the waves rolled in we all dived into them. The water was so clear and you could see all the different coloured shades as they went out deeper and further out to the ocean.

After we had been for our swim we came back onto the sandy surface and sunbathed again.

When it was time to go home we had a bit of difficulty as we were all burnt. Well that was a relaxing day and although we were burnt we decided to go down again tomorrow but under differend and safer precautions.

Year 9

Although the content is very similar to previous examples on this topic, the structure here is much superior. The very first sentence refers to the appropriate tense ("... I would like ..."), and there is a real and successful attempt to follow through with internal descriptions as well as external ones ("... I thought to myself ..."). The external world too is effectively described, giving the reader a specific and at times vivid mental picture of the scene.

3A. Transitional

(1) What to do on a really hot day

On a really hot day the best place to be is the beach. Soaking up the sun, and then going for a swim to cool off. If the water is really cold its the best place to be, but you have to be careful.

On the really hot days, or for any day, numerous numbers of surfers gather in the water. If you are unlucky enough to have been run down by a surfboard, you'll know its not very nice.

Hot weather usually attracts hordes of sunseekers, who usually make a lot of comotion, especially in the water. This also attracts hordes of sharks, who like eating sunseekers, so you really must be careful.

Lots of people come to the beach on hot days, not to swim or surf, or build sand castles but to get a tan. So these people put on the Baby Oil and lay in the sun all day. At the end of the day they find themselves looking like a beetroot, and not very tanned.

So you really must be careful at the beach on really hot days, but even though there are a few minor problems involved it is still the best place to be on a hot day.

Year 9

This writer appears to be reaching towards a relational structure but is unable to make it. The style of response is original (most respondents on this topic wrote of their own experiences), and the writer uses a cyclical

form in almost a poetic fashion. Nevertheless, the attempt at an overall thematic structure does not come off; the concluding phrase is quite weak.

(2) What the world will be like in the year 2000

> I don't really know what the world will be like then because it depends what sort of things happen. For all we know this world could be taken over by robots or the whole earth could be destroyed. But the most likely thing to happen would be for the world to stay as it is but new inventions and buildings, population increase or decrease to arise. There will most probably either be a decrease or increase in politics. It will most probably have more organisation than before.
>
> But also by then Australia may have a very low population because of diseases spreading rapidly and country's that were suffering might be a lot better off. Schools may have stopped or changed in various ways. All sorts of animals may be extinct. There may be different sorts of transport and all motor vehicles finished for ever.
>
> But hopefully the world will stay similar to what it is now.
>
> Year 9

This essay raises several issues - mostly drawn or extrapolated from personal experience - and attempts to integrate them. Had this been successful, the result would be at the relational level. In the event, the writer draws the various lines - and then gives up, as admitted in the last sentence.

4. Relational

The major difference between multi-structural and relational writing is best summed up in the word: integration. The point to be made is visited from several inter-related angles: the content, however is still essentially drawn from personal experience. Hypothetical situations, or flights of imagination, are not dealt with.

This integrative nature of relational writing is seen in effective changes of tense, the description of the feelings of others besides the narrator, and the adoption of alternative points of view and observer positions. This facility with the conventions of expression can produce its own effect, and to that extent may veer towards the poetic function of writing, but it is not done systematically or consistently.

(1) Country School

> The young girl came bouncing round the corner chirping and bright. Her hair sun bright shining, teeth of an aboriginie dressed in the prettiest grass green dress.
>
> She boards the bus greeted by a snarling busdriver, who obviously had a late night and getting up with the birds, would not help matters.

She's one for telling tales as big as mountains, and her friends listen carefully with fly-catching mouths.

The bus jerks and their on their way to school. The weather ice cold invites the fog to settle on the bus window while the children engrave their initials.

The endless lucious grass is streched as wide as the ocean, but soon the school house is in sight, a blob in the not so far distance.

Now they're all settled in class with teacher out front discussing the road to success to her basset hound pupils looking very vague. Her superiority is displayed in the way she lets her pupils know whose boss!

Year 10

The writer here has a definite point to make, and does so quite successfully. She intuits to some extent the feelings and motives of all participants: the girl, her friends, the busdriver and the teacher. Some terms of phrase are particularly skilful; "tales as big as mountains", for example, conveys several messages given the context. There is a total vivid picture presented here, with an underlying structure which has much potential for generalization and elaboration (e.g. the last sentence).

(2) King of the Tip

Yes, I am an oldy now, centred on a pile of rubbish called Cardiff Dump. I can just remember the good old days when a man of high class and quality polished and looked after me as if I were his most treasured possession. After that I had a spot of bad luck. My beloved owner died. I cannot tell you how sad I was.

From that day on, I was not even as much as looked at, let alone polished. My condition gradually deteriorated. One morning my mistress gave me away to some poor old man.

Then I really suffered. I was chewed by an ugly great dog. I was kicked from one corner to another. I was trod on, damaged and abused. How I survived for six months I do not know.

Now I have the honoured position of King of the Tip.

Year 10

In this example the writer attempts to detach himself by using the object to address the reader. He can express generalized feelings but his story is still embedded in a totally concrete context based on the writer's experiences. There has been little attempt to draw on his imagination. Rather the incidents describe generalized concrete experience which could be applied to a number of objects. The writer has used obvious generalities that lack imaginative or abstract qualities, for example, "I can just

remember the good old days", "a man of high class and quality". Although the structure of this composition shows the beginnings of an ability to plan and develop a plot, the writer has relied on a time sequence (a concrete property) to link the incidents he describes. Thus his arrangement of the story and its content are based totally on the author's empirical world.

Thus creative writing at the relational level can be said to possess structure, plot development and generalized experiences and feelings, but it is not until the extended abstract level that creative writing reveals imaginative qualities and total detachment by the writer if he chooses.

(3) The job I'd really like to do if I could

> The job that I really would like to do would be a child sychiatrist. I would like to do this because in this god forsaken world every kid needs as much help as they can get.
>
> In today's society kids haven't got much hope. They have too many pressures on them and most find that the only way to relieve these pressures is to take them all out on something or someone.
>
> If I could be a really good syciatrist I would definitely help as many kids as I could because as a child myself, now, I believe that when I get old enough to be what I want life will be extremely harder on the kids of that generation and time. When they are old enough to understand this world kids wish they couldn't, because the world is such a 'rat-race'.
>
> I believe that the kids of that generation are going to need as much help as possible because one day they will be the adults of the world and they will take out all their frustration and anger that has built up in side of them, from living in this world, and they will take it out on anything or anyone they can in such a way that will probably have a terrible effect on the whole of the world.
>
> I believe that if kids could take out their anger on something that would have no adverse effect on anyone they could probably survive.
>
> Year 9

The writer has presented a clear, integrated case, based firmly on her own experience and generalizing from that; "... if kids could take out their anger ..." and she gives constructive, if highly generalized, suggestions to deal with that. The writing is not good, but the structure is clearly relational.

(4) Food

'Food', a simple fourlettered word, but the most important thing of this earth. It is impossible to live without food. I once knew a young married couple who decided to live on love alone, ... they died. I believe when God put Adam on the earth the first things he looked for was food and a woman, luckily for us he found both.

I, myself love food and would be exceedingly upset if it didn't exist. If this was so there would be no such thing as a lunchbreak or tea break and you would have to work all day without a rest.

As you probably know I am a great chef and coniseur of fine foods, for example: I once made a cake which I later named a "Marble Cake" for the simple reason that its texture, wieght and hardness showed a remarkable resemblance to that of marble.

Just pretend that food didn't and never did exist and that we derived all our energy from the sun. In that case 3/4 of the world would no longer be starving and several wars over greed for land may have been prevented. Food is really a hidden curse!!

Year 10

This writer not only uses good grammar and an interesting choice of words but manages to utilize successfully a complex writing strategy which results in the effective tongue-in-cheek tone found within the composition, which gives the piece its relational structure. Like most expressive compositions it emphasizes the important place of "I", and has largely been the product of a free flow of ideas and is relatively unstructured from paragraph to paragraph. Each paragraph gives us a new idea and the last paragraph gives us a completely new mood (which shouldn't necessarily be thought insincere because it's juxtaposed with flippancy). This is the effect of a spontaneous flow of personal reflections upon a specific subject.

4A. Transitional A 4A transitional work is one which reaches towards the extended abstract but does not quite make it. These responses are relatively common in senior high school: more so than extended abstract as such. Perhaps the facility with the medium which is intrinsic to many extended abstract responses is simply lacking in high school writing, whereas this is not so clearly the case in other school subjects.

The first is a good example of the transitional style, but the level is mixed: commencing 3A and ending 4A.

(1) Who Would I Most Like To Be Like

If I had a choice of who I'd most like to be like, I'd be it. Like all human nature, greedy, I would

jump for the perfect person. Imagine, being unique among mankind, the strength of superman, heroism of "Roger Ramjet, looks of Mr. World, Humoar of Dick Emergy, Benny Hill etc. With these I would become the best looking, heroic, strong, super-personality with a 150+ I.Q. on the planet earth.

Citizens would love my powers and fear nothing; except me. A multi-personality, would drive me to the top; my personality. I would be the power of the country, let alone the leader. With me in Government there would be no need for parties. Dont get the wrong idea, for the previous sentence was ambiguous. I love birthday parties. What I mean is that a person can see ten different views. Ten different qualities of powers and leadership. Even more, in every personality in me. Individual characters promote there own ideas in me, in government.

My super-human character would make big game criminals resort to busting donald duck piggy banks. Law and order would find themselves redundant or wheeling brooms or in sewerage works. Mine would be a perfect world, floodless, antiwar, antiviolent, thanks to my wonderful powers, (also unemployed).

Though it wouldn't work. This just isn't a human bearable environment. It would be torchure, to restrict, or limit, human nature of mankind. In a way I knew I was destroying the Earth and I must leave.

Year 9

The style and some references (to comic and TV characters) are highly concrete, suggesting a 3A response. On the other hand, the generalization from there to "the perfect person" is relational; while the last paragraph has overtones of extended abstract. This mixture of levels and of competencies make this a transitional response, but, possibly because of lack of writing skill, it is not consistently at 4A level.

(2) Noah was absolutely amazed when ...

Noah was absolutely amazed when he arrived at the gay liberation society meeting. Noah was the type of unique person who was always experimenting and trying at new ways of approaching things. To put it straight, he was bored with life and the way people were living it. Don't get the wrong picture, Noah was not gay (not that he had anything against those that were), he was just going along to see how these people had decided to cope with their lives, and live them out.

Previous to this Noah had tried to paint himself into a picture! He did not try to paint a picture of himself, but be part of it. A problem arose though when he got bored with this (he was the type of person who needed to be continually doing some-

thing) and had to leave it, this meant that the picture could never be finished. Also, if Noah tried to sell the painting, ... well the difficulties were obvious. (I'm quite sure I wouldn't like to sell myself!).

Noah had a collection of rabbits, that he had salvaged from the Y.S.P.C.A. He had saved them from being given to hospitals for experimentation. Noah was really doing to the rabbits himself what he as stopping the hospitals from doing to them for the reason he wanted them, was to try to develope a short eared rabbit, with only eyeteeth. Noah had been trying to succeed in this since he was eleven years of age, and now at twenty years of age, and now at twenty seven, all he had succeeded in doing was making slow rabbits that would'nt reproduce (why? Is totally un-be-known to me, or Noah for that matter).

Noah had been ridiculed all throughout his life, no-one could ever understand a person with a different ...

Year 9

This highly original essay is difficult to assess because it is unfinished. So far, however, it shows clear extended abstract elements, which, if the last sentence, in elaboration, were to be integrated with the first paragraph "... who was always experimenting ..." would be classified as extended abstract. As it stands, however, it is typical of a 4A level.

5. Extended Abstract

One attribute of extended abstract writing is treating the language or medium as an "object": "The words themselves, and all they refer to, are selected to make an arrangement, a formal pattern" (Britton et al on the poetic function). However the purpose of writing helps to determine the mode of expression, and as the pupil develops his writing ability, he will be capable of selecting and writing in the transactional (informative), poetic or mature expressive modes, in accord with his purpose of writing.

Writing reveals almost complete detachment by the writer if he chooses: he can refer to hypothetical situations and to abstract principle (if appropriate) or to metaphoric allusion. The basic characteristic however, whether transactional, expressive or poetic, is mastery of the medium of language, so that the writer can create the effect he wants.

As noted in the previous section, extended abstract writing is in fact quite rare in high school, simply because it does demand a degree both of commitment and of sheer literary skill. Nevertheless, given that commitment, it may be found, as the first example shows:

(1) Signs of Spring

It was in the spaces of a thick green bush that was kissed by the vibrant rays of the sun. In the clearing a young couple sat beside a blue glassy stream, that laughed and bubbled over the mossy pebbles.

The young man, thin and tanned, smiled warmly and picked a small flower and placed it in the girl's long brown hair. She laughed contentedly - but neither spoke a word. I looked deep at their relationship - and the disasters of the world flashed past me in one quick second. Then suddenly I realized, all the money in the world, all the wars, battles and stife could not affect or change someone as much as love.

The couple still sat silently - but their silence was deafening. It screamed out to the world - scratched, tore and pounded at all the hearts that would listen. Listen?

Have you ever heard love, have you ever stopped to listen? How many of you have ever sat silently like this couple and listened to the love that surrounds you? Maybe some of you, or maybe you just can't hear, because you live in your world of pollution, over-population and drugs.

Look deep - do you see the couple in the clearing? They are richer and happier than all of you. They are uninhibited and touched by love.

I walked away slowly, looking at the fresh flowers, listening to the young birds. It was Spring, I could tell. It wrapped itself around me and showed me love - nothing is more beautiful than the signs of Spring.

Year 9

This carefully constructed composition possesses a free-flowing quality that conceals its formal structure. The writer uses the formal properties of written language (e.g. sentence structure and length, punctuation) in conjunction with vivid imagery and a simple story to effectively create and change moods. These qualities complement and reinforce the "message" she wishes to communicate to the reader. In this sense the composition could be regarded as "language art". In comparison with the examples of writing at the earlier levels, where the writing is based solely on the student's concrete empirical experience, this composition reveals the writer's ability to employ elements and their combinations both from her reality and from imagined possibilities. She is able to go beyond her concrete experience to introduce hypothetical aspects or abstract elements into the situation. This imaginative quality is reflected not only in the total construction, but also in the parts of the composition and in the

way they are linked together. For example, the thought that "Spring showed me the beauty of love" is revealed in a movement from the concrete (the couple in the clearing, the fresh flowers ...) to the abstract (Spring wrapped itself around me). This writer is also able to allow the variables (real and imagined) of the situation to interact, so that these can be considered and their interactions used in the construction of a unified and complete composition. There is an acceptance of lack of closure in this writing: questions are raised and held open. The writer's purpose is not to inform but simply to ask the reader to consider. The composition possesses many thoughts that are generally applicable, not specific; at the same time, the author indicates her awareness of the particularity of the experiences she introduces. These concrete elements are used simply to illustrate more abstract thoughts, thereby communicating thoughts and feelings that encompass both. This student is able to use written language to create moods (e.g. "screamed, scratched, tore and pounded"), and to express imagined possibilities to convey thinking that goes beyond concrete experience.

(2) There's the Rub

I know no peace in these days
of blood dripping, garbage bin destined foetus'
rudely crucified upon every notice board:
staring staring technicolour postcards
of pelvic atrocities
snap frozen in pain
for some photographer's gain.

"Kill the Bill .....
say NO!" it screams.
So I stand resolute erect and say,
"no"
but alas, the corpse lying still
racked cherry-dipped and wretched.
(I even held my breath and turned blue
for good measure)
Reading on undauntless,
fearing not the inevitable logic
that they continually warn quivers upon the brink
to claw my mind into shreds of submissiveness.

On and on "Ten weeks ... Write your
Federal Member ..." and ---
"From the appearance of the developing
external organs (?? - probably refers to the fact
that men have only nine toes) it is possible
to recognise the foetus as a boy".

I'm suddenly demoralized and feel
not for the dead kid (it is a smile
I see upon his face) but for
the self-perpetuating martyrs

and as the debate whittles into myth
I'd like to spew upon the green carpet
of the House (That'd make the bastards
cross the floor).
I wonder if they have ever stopped fiddling
with their external organs
long enough
to take a look at the issue.
(there they will see themselves
and be oldboys with murder)

Year 11

In commenting on this poem, the poet himself says:

> I wrote this poem back in the 1972 days of the never-ending abortion debates. I was personally indignant and bitter but managed to subordinate this to the discipline required to create a satisfactory and effective artistic object. It is an object which does give my personal feelings yet does so in a planned, calculated and artistically desirable way. A piece of prose containing this view may be little more than expressive writing but here the poetic object is too obvious; the writer has been careful to create something artistically satisfying as well as succeeding in the transferal of his own opinion.

Although there is an expressive element here, the writer is clearly using language as an object; the puns and double-takes, surprise use of imagery ("... it is a smile I see ...") and this is what marks it out as extended abstract writing.

Reliability of SOLO Ratings

Two separate sets of ratings were carried out by two raters working independently. In one sample (the first) the correlation between raters was .79 (N = 63); and in the second, .83 (N = 51). These figures, for essay-type ratings, are satisfactorily high.

A further breakdown on the first sample showed that 45% of the ratings agreed exactly, 44% differed by only half a level, 10% by 1 SOLO level and 2% (1 essay) by more than one SOLO level.

On the second sample, 58% of the ratings agreed exactly, 36% differed by half a SOLO level, and 6% by one or more levels.

Implications for Teaching

The creative writing studies show more clearly than in other fields how widely different students' work can be at the same year level. It is therefore more difficult here than in other subjects for teachers to have any generalized expectations for a class.

Probably two factors impressed us, in assessing student writing, that might account for this instability:

1. The degree of commitment the student has. When a student becomes really interested and involved in his topic he begins to "play" with language, producing effects and images that may be highly productive and evocative. He does not do this, however, if he simply doesn't feel like playing.

2. The degree of skill in using language that the student has. This factor seemed particularly important, and possibly more even than lack of interest, prevents adequate representation at the relational and especially the extended abstract levels. One of the components of these highest levels is in fact mastery of language.

There are no doubt many techniques the teacher can use to maximise the chance that the student is involved: writing stories of completely free choice, for example, rather than the old fashioned and mandatory "What I did on my holidays".

Getting students to write copiously is also one of the major means of increasing skill - sheer practice, with feedback and opportunities for self-criticism.

Some relevant findings on this question of practice were obtained in a study by Annells et al (1975) who replicated Britton's study in a representative sample of Tasmanian high schools. They collected writing samples of all kinds (including homework and mathematics exercises, but excluding art) and found an average of 1.7 pages were submitted in Year 7 and 2.8 pages in Year 10; on any one day over 40% of the students submitted no continuous writing at all.

Of the writing collected, almost all was classified as transactional, in Britton's terms, i.e. the function of passing on information. Most of this (60%) was for the purpose of doing exercises (problems, short-answer responses) and 35% was continuous writing (relating facts, mostly); 3% was poetic in function, and only 1% expressive. Paradoxically, though, most teachers (70% of 173 circulated) thought that both expressive and poetic writing performed an important function, and that appropriate experiences should be provided.

There is little reason to suppose that the situation would be different in other Australian States, and on this evidence, the variability of SOLO level in creative writing is more easily understandable. It would appear that there is, under current teaching practices - in all

subjects, but especially in English - considerable room for improvement in the treatment of writing, particularly in the expressive mode. It seems fairly certain that many students are just not being given enough practice in writing to master even elementary language skills.

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EXAMPLES OF THE TAXONOMY IN USE

4. GEOGRAPHY

Section C: Examples of the Taxonomy in Use

4. Geography

In order to understand geographical problems and settings the student needs to be able to interpret data presented in many forms, for example maps, graphs, diagrams, statistical tables and written descriptions. To assess students' understanding and reasoning ability Rhys (1976) designed five items utilizing a variety of methods of data presentation. The following three items were part of this research. The responses were given by students aged between 9.8 and 16.3 years.

The following passage was taken from a school textbook; although it is longer than necessary it conveys a good geographical problem setting.

(1) Item 1. Farming in the Andes

> Antonio Arango invested his life-savings in the purchase of a fifty-acre plot of land in the Magdalena Valley, high up amongst the slopes of the Andes in South America. The land was covered with tall timber, which showed the fertility of the soil. "Where such big trees grow, the soil is good," said Antonio to himself, and he gazed with satisfaction at the thick layer of vegetable top-soil which could be seen in the cutting made by the brook. The water of the brook was crystal clear, so crystalline that Antonio and his sons christened it Diamond Brook.
>
> Antonio sharpened his axe, the iron that was to conquer the woodland. The timber, when it had been cut, could not be used because there were no roads by which to remove it nor neighbouring towns to buy it. So he let a few days' sunshine dry the fallen leaves and then set fire to them. Other settlers were doing the same in other parts of the mountains. The blaze was enormous.
>
> At long last the ground was cleared and Antonio sowed it with maize, keeping five acres as pasture for his cow. And, on the high ground he built a house, too. Antonio named the house after his wife, *La Isabella*. The first harvest was encouraging. Antonio was well pleased with his efforts, so he went on sowing maize. But things were changing.
>
> Diamond Brook, which had once been brimming and crystal-clear through the year, had shrunk to a thread of water in summer-time. In the rainy season it was a yellow flood tearing loose rocks and mud and lumps of soil. The harvests were growing smaller. Antonio sold the cow because the pasture was no longer enough for it to live on. Things were not going right for him at all. One day, when he was sowing maize, his spade struck solid rock. The vegetable topsoil had become so thin that already rocky outcrops were appearing everywhere.

There was no money in the house. The children had nothing to eat. Lastly, Diamond Brook vanished and only its stoney channel was left. Like so many other settlers, Antonio Arango sought another stretch of woodland to begin again.

Question 1: Why did the deep fertile soil cover disappear and make farming impossible?

Examples of Responses

1. Pre-structural

(a) "Diamond Brook, which had been brimming and crystal clear throughout the year had shrunk to a thread of water in the summer time. In the rainy season it was a yellow flood tearing loose rocks and lumps of soil."

This provides an example of a tautological response where the student repeats part of the passage because he has failed to relate the question to the information given. He has failed to appreciate the field-of-action described by the presented material.

(b) "Because solid rock was under the soil."

This response is an association with a perceptually dominating aspect of the story. The student has seized on the end-product of the sequence of erosion while remaining oblivious to Antonio's role in disturbing the existing balance of forces.

(c) "Because Diamond Brook was drying up."

This response shows the student's failure to recognize causes and effects in the passage. He has chosen a sentence without considering whether it was logically related to the question.

(d) "Because the sun was too hot."

This response is an example of irrelevancy. The student could not or does not relate the question to the passage. It probably is an association from his previous learning experiences of hot sun causing barren soil.

2. Uni-structural

(a) "Because the big trees had been chopped down."

(b) "The soil was washed away by flooding."

(c) "The deep fertile cover disappeared because of the flooding which caused the top soil to wash away and leave rocky ground making farming impossible."

In each of these responses the student attempts an analysis using the data but fails to see more than one piece of evidence; he sees the problem situation as possessing only one dimension and closes on this without recognizing that a number of factors were operating. There is a simple

recognition of a destructive element with no appreciation of the fact that it had not operated in the state of natural equilibrium which existed before.

(d) "The trees provided leaf litter making the ground fertile. When all the trees were removed there was no longer any goodness given to the soil."

(e) "Because when the trees were cut down no more minerals were given into the soil which made it dry and lifeless."

In each of these responses the students have considered only one relevant dimension before making a decision (closing). However, they have interpreted the question as "why did the fertile nature disappear" not "why did the soil disappear". Their interpretation illustrates the one-dimensional approach which is characteristic of the uni-structural response. Instead of seeing this as one factor among many changes in the environment they have focussed on the fertile nature of the soil as the only aspect to be considered.

3. Multi-structural

(a) "After the trees were cut down and it rained, the water ran down the slopes and eroded or washed away the fertile soil making it impossible to cultivate."

(b) "Because when the trees were taken away, the rain fell direct on to the soil washing it away down the hillside."

Both these responses show that the students have a clear awareness of cause and effect. They have considered more than one aspect of the situation and they have started to realize that a combination of events caused the soil to disappear. However, they are not yet able to look at the total combination of factors (for example, continuous sowing of maize) and so even though each analysis is in terms of the material presented it is limited by the student's perception of the situation. It is seen as a series of two major events (felled trees followed by rain) not as the natural balance being altered by the interaction of a number of factors.

(c) "When Antonio cut down the trees, the soil was no longer held together and also when he set fire to clear the land the thick layer of humus was removed. Without the humus the soil was no longer rich and as the soil was no longer kept together by the trees it was much easier for erosion to take place."

This student has mentioned a number of factors and has a clear grasp of the content of the passage. However her response is bound by the dominant content of the passage, Antonio's story; she has failed to mention the importance of cumulative actions on the environment - the settlers all destroyed the timber, and Antonio continuously sowed maize. The student's responses indicate that they see total soil erosion as an almost immediate

consequence of the man's action, rather than seeing this passage as a story about the progressive destruction of a naturally balanced environment.

4. Relational

(a) "Antonio had found what appeared to be good land and with high hopes and great ambitions he had cleared and begun to plough that land continuously sowing and harvesting his crop and demanding more and more from his land until eventually his land as well as his brook had run dry. Antonio had spared little thought to his future and had only concentrated on the present using his main source of living to the fullest extent."

This student has obviously grasped the main theme of the passage - man's destruction of his environment through thoughtless or greedy practices, and his response indicates he is capable of answering the question well. However his willingness to generalize from the content of the passage has caused him to almost fail to write down the relevant points. He has mentioned the clearing of the land and repeated cropping with nothing put back into the soil, but his enthusiasm for generalizing has made him lose sight of two important factors,

(i) that all the settlers cleared the mountain-side,

(ii) that rain and wind eventually eroded the soil because there was nothing to hold it.

This response provides a good example of how questioning or commenting from the teacher would encourage the student to respond at a higher level (extended abstract in this case).

(b) "Because it was a mountain-side and all the natural vegetation was cleared by the settlers and they didn't do anything to prevent the soil being eroded by the elements. They may have even ploughed up and down instead of around."

This student has grasped the situation but he is not yet capable of considering the interaction of all the contributing factors. His explanation contains the important factors but it is not comprehensive. He is capable of generalizing from the particular story of Antonio to see that the destruction was caused by the total behaviour of the settlers. Thus his ability to generalize has helped him to note an additional dimension of the problem situation that many students responding at the multi-structural level missed.

5. Extended Abstract

(a) "The settlers did not have sufficient knowledge of the environment to know that the soil was kept deep and fertile because of the tall timber growing there. The

trees provided humus from their dead leaves and the roots held the soil together and put back minerals. When the settlers cleared the land and burnt off they left the soil unprotected from wind and rain so erosion occurred. The crops that Antonio planted did not give anything back to the soil so after the first year his harvest became poorer. He lost the top soil and did not have the use of fertilizers like today's farmers so farming eventually became impossible."

(b) "Through getting rid of the trees, they made it possible for the rain to wash the good soil away. This is so because the roots of the trees hold the soil in place. The fact that he always planted maize would not have helped because when farming crops should be changed to replace what other crops take out."

By seeing the situation as the interaction of a number of factors, these students have been able to provide a comprehensive explanation that includes content from the passage, generalizations and knowledge from outside the passage. These responses reveal the students' awareness of how the natural balance in an environment can be destroyed by man's actions.

(2) Item 2. Crofting on the Isle of Lewis (Rhys, 1972)

In this test the students were required to examine a proposition after considering information setting out the problem facing crofter farmers in the Isle of Lewis. Maps were provided showing the essential geographical features of the island and bringing out the generally poor quality of the land. Demographic, rainfall and temperature charts were provided and also charts showing the proportion and nature of crops as against pasture and the number of sheep and cattle. Most of the maps and charts are set out in Fig. 1G.*

The proposition to be examined was put in the question form:

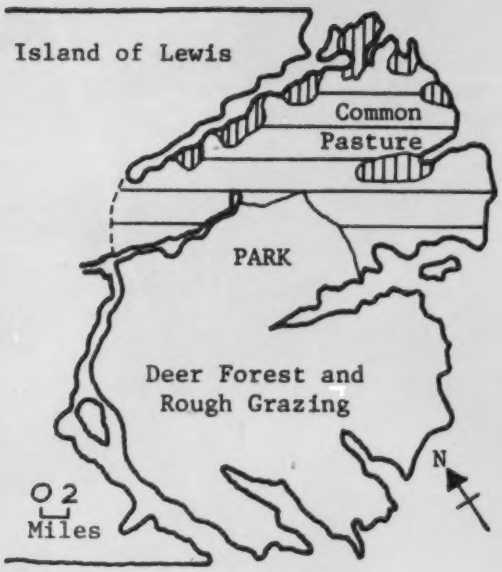
"Are the crofters making the best use of their land by growing crops only over such a small area?"

It should be clear to the reader that the data given was meant to show that only a very modest standard of life is available to the few people who live in the Park district on the Island of Lewis. Much of the land is left to the ravages of nature with the sparse population gathered on the seaward fringes. The cultivable land characteristically occurs in long narrow strips along the coast or up the valleys. The proposition was designed to focus attention upon the contrast between the overall areal extent of the district of Park, and the low density peripheral occupation

* See appendix to this section for a comment on the presentation of data in this Test Item.

Figure 1G

PARK - A LEWIS CROFTING DISTRICT



Croft Areas (houses with land).

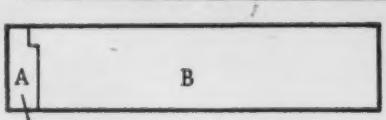
British Isles Farming

Mainly poor mountainous farmland

Mainly good lowland farmland

LAND USE - 1958

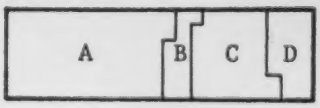
(i) Composition of entire area



A - Crops and Grass

B - Common Pasture (poor quality, ill-drained with areas of rock and peat.)

(ii) Composition of Crops and Grass



A - Natural Grass

B - Sown Grass

C - Oats

D - Potatoes

(iii) Livestock

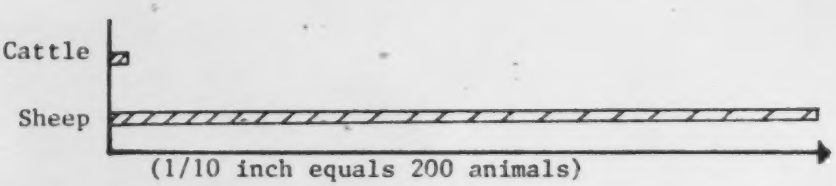
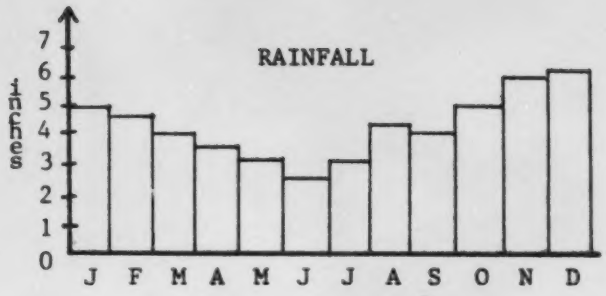
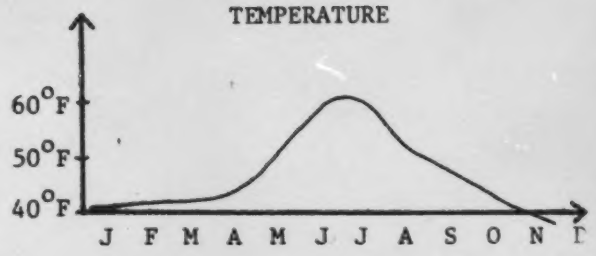


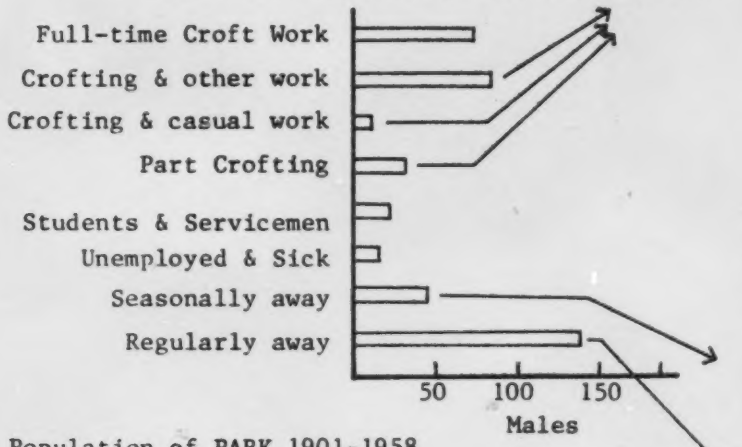
Figure IG (Cont'd.)



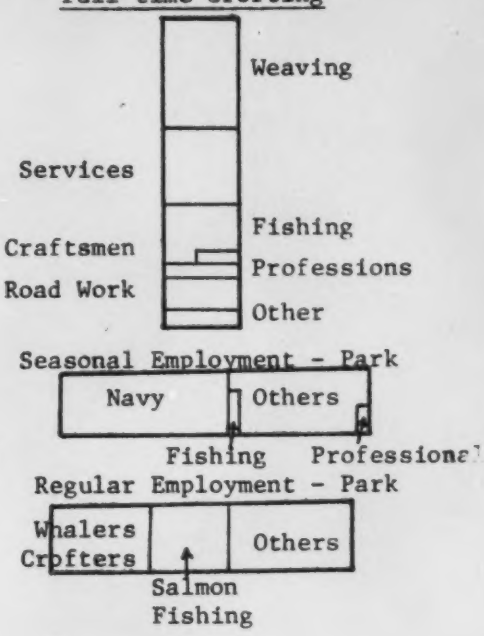


Occupational Structure 1958

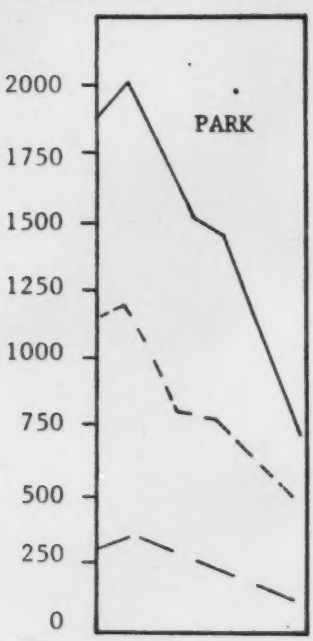
Males in Working Age Group (15-64 yrs.)



Occupations other than full-time crofting



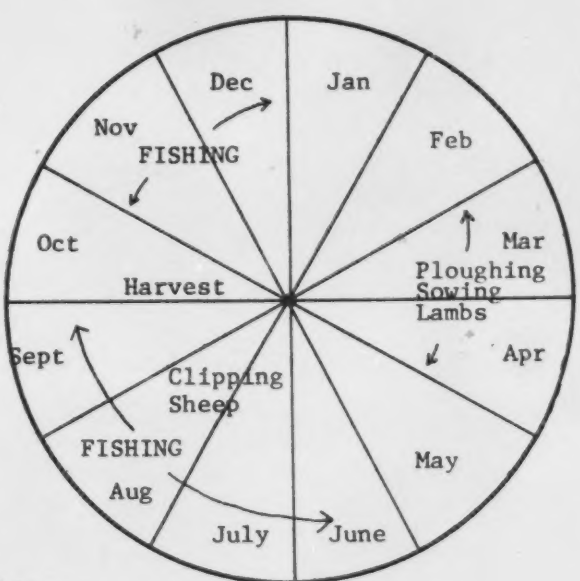
Population of PARK 1901-1958



---- Crofting areas with a fishing bias

— — Crofting areas with a farming bias

SEASONAL WORK ON A CROFT IN PARK



where the critical features are the harshness of the climate and the infertility of much of the terrain.

Examples of Responses

1. Pre-structural

(a) "Yes, because they've got the beauty of the deer in the forest, and they can have the pleasure of going for walks in the forest, and see lots of lovely deer and spotted fawn."

This answer is characteristic of pre-structural thinking in that the student's response to the situation is not oriented to reality. The judgment is egocentric and made in terms of personal pleasure.

(b) "No, it seems such a waste of ground with only a few crops in a teeny-weeny bit of ground."

This is an intuitive reaction to the quantity of land available. There has been no analysis of the geographical nature of the environment. The answer is basically a personal opinion with no evidence from the data to support it.

2. Uni-structural

(a) "No, because the crofters could grow more varied crops if they used some of the common pasture."

(b) "No, because they care more for their animals than they do for their crops. I think they should have more crops and less pasture even if they did have a lot of animals."

Both students have considered one aspect of the data - the perceptually dominating feature, namely, the amount of land available - and then made a decision (closed) using this single piece of evidence to support their judgments. In contrast to the pre-structural responses, use of the data here is reality-oriented but the only aspect that is considered is based on immediately observable data which can be related to the student's experience.

(c) "They've got a lot of animals and they take up a lot of area."

Again, the student has considered only one aspect of the data, the number of animals, before making his decision (closing). To him this is the dominant piece of visual evidence, and after perceiving this one dimension of the problem he has closed on this thus not allowing himself to think about why there are so many animals.

3. Multi-structural

(a) "Yes because they do not need too many crops. Since the land is poor they need a lot of pasture to make sure the sheep and cattle are well fed."

This student has based his decision (closed) on the more obvious aspects of the data but because he is bound by the content his reasoning is limited. The information he has considered (crops and animals) is concrete - part of his previous experience. He was, for example, unable to consider the implications of the rainfall charts.

(b) "Yes, as it says, most of the land is of poor quality, ill-drained, with areas of rock and peat. It would cost many thousands of pounds to restore the land to any use except feeding his cattle."

This student has considered a few dimensions which stand out for him before making his decision (closing) and he uses only these to support his judgment. His answer is restricted to certain aspects of the data and is bound by the content that he can relate to his previous experience.

4. Relational

(a) "Yes, I think they are using their land to full extent because what they don't grow they can get by selling the fish that they catch, to other places far inland who cannot fish. Also, on the rough ground they can graze their cattle and sheep from which they can obtain milk and also meat."

This student has used a few specific facts from the available information and generalized from these in forming his judgment. The response illustrates relational thinking in that the student can handle generalized aspects based on a few specific verifiable instances but does not look for negative instances. Although the student uses the data to endorse the crofters' farming practice he fails to use the data to consider what would happen if they farmed differently. He does not consider the rainfall pattern or that the poor soil might not support a complete range of crops. The student responding at the relational level typically uses the data to consider the set of events that will occur, but the extended abstract respondent uses the data to infer both the set of events that will occur and also its complementary set - those events that will not occur - thus extended abstract responses use the total set of outcomes to make a comprehensive judgment.

(b) "I believe that the crofters are correct in growing only a few different types of crops. As the island of Lewis is situated on the far north-west of Britain it would have an entirely different weather pattern than that of London, for example. First, it is considerably colder, the maximum temperature being about 57°F. Being where it is on the coast it would be exposed to the Atlantic storms and have a heavy rainfall. With such conditions being present the crops they grow must be very hardy. The food they grow for themselves there is oats, which is one of

the hardiest cereals, and potatoes, which is easy to grow and a good food. Grass grows profoundly here so it must be suitable to the climate, so the people use the natural grass and the grass they have sown to feed the Park's sheep and cattle."

This student is able to consider all the dimensions represented in the data but he treats them separately (does not consider the interactions) or in combination when his previous experience guarantees a direct relationship (uniqueness of outcome); for example, he is prepared to make the link between weather conditions and crop type. He has generalized from the concrete aspects of the data, for example, "oats, which is one of the hardiest cereals", but his willingness to generalize in order to support his decision "I believe that the crofters are correct" (closure) has caused him to over-generalize and in fact misinterpret the "Land Use" data, viz., "grass grows profoundly". This is a good example of a relational level response because it reveals an ability and a willingness to use all the dimensions represented in the data, but, at the same time, shows the need to close on certain aspects and to generalize from these. These characteristics prevent the respondent from considering the situation hypothetically and so holding a decision open until all the possibilities have been considered.

5. Extended Abstract

(a) "I think they are probably quite right in applying the policy as, in addition to the fact that the common pasture is of poor quality, to farm extensively the whole area would engage the costly business of clearing the comparatively large deer forest. Clearly their best policy is being practical, and to nearly ignore the poor ground except for cattle grazing, and taking to the sea where a richer crop of whale, salmon and other fish can be obtained. If crop farming was extensively practised the harvesting would also be a big headache as the harvesting months of September and October are among the months with the highest rainfall which makes it very unfavourable for harvesting crops. Lastly, if farming was practised, the few males there would have difficulty in finding work, as the island is very small in itself, and they may have to go to the mainland to find it."

This response represents a detailed systematic appraisal of the difficulties presented to the crofters by their restricted environment, and the potential difficulties if alternatives were followed up. The sentence "If crop farming was extensively practised ..." is an example of this. The student is capable of considering a hypothetical course of action and its possible outcomes. He has held the question open while considering the implications of each course of action.

(b) "The crofters are being sensible in only having small areas of crops because the common pasture is of poor quality, ill-drained with areas of rock and peat. The composition of the croft areas are part of grass, sown grass, oats and potatoes, and this encourages them with crops and livestock which has many sheep and about 40 cattle. It seems more sheltered in those croft areas than in the common pasture and if you notice it on the map, the croft areas are situated near the sea which allows the rainwater to be drained into the sea more easily. Also of course they are in a position to use fishing as another important source of income. Good farming would be impossible in the common pasture of these people in the island of Lewis."

In both these responses there is evidence of the students' ability to weigh the proposition against the elements of the actual environment in which the crofters live - particularly those which restrict the action of the farmers and where there is a conflict between the quality and the amount of land available. The extended abstract response resolves the conflict between the land apparently available and unused and its quality. To do this the student needs to look at the total interaction of all factors of the environment.

Question 2: "Why has the number of people living here gone down so steadily over the past fifty years?"

Examples of Responses

1. Pre-structural

(a) "Not many people like living on an island."

(b) "When they went fishing some might have had their boats uptipped, and sunk, and were drowned."

These responses illustrate that the dimensions in the data have remained undifferentiated - a typical feature of this response level. Both students have closed or come to a decision without attempting to use the data. Instead each response appears to be an association with a perceptually or emotionally dominating aspect of life in Park - to the first student, living on an island, and the second, the dangers associated with fishing.

(c) "Because they've moved to other countries and there's less people living there."

This response illustrates the fact that a pre-structural response often shows a willingness to close or come to a decision without attempting to use the data. This characteristic often leads persons responding at this level to refer to or repeat part of the question rather than the information given. In this example the student says the population is decreasing because people have left.

2. Uni-structural

(a) "They moved into Scotland to find more land and more work."

(b) "Because jobs are getting scarcer."

(c) "Because the people do not like the hard work of farming, and have got away from the Isle of Lewis."

Each of these students has seen one dimension to the problem and then made his decision using this aspect. The reason given in each answer is oriented to the realities of the situation faced by the people of Park, but because the uni-structural respondent closes on a single aspect there has been no attempt to look back to the data to provide tangible support for the judgments.

3. Multi-structural

(a) "It has dropped steadily because it is a small island and it is very wet and there is not a great deal of food for everyone on the island."

(b) "It is only a small island and Scotland is much bigger. They had too many people there and farms would get smaller with crowding. Scotland could attract them to have larger farms."

These students have attempted an analysis using some of the information available. They have made a limited deduction after considering a few dimensions of the problem which stand out for them, for example, limited size of the island, and the severity of the weather. These examples illustrate the multi-structural level of response which is typically restricted to a firm closure on the basis of a limited number of aspects of the data.

4. Relational

"The first settlers found they could get a good living from this part of the island. But as the years went by it got worse and worse because prospects were limited. The people started to move elsewhere to find something before it was too late."

This student has generalized from the basis of the population graph. In his use of the data he has realized that the prospects were limited but instead of holding his view open he has closed on the aspects of declining population and limited prospects and then used these as a basis to generalize that the quality of land and farming had also declined over the years. Thus his final judgment of the situation based on a generalization from specific concrete aspects was "they moved before it was too late". The student is capable of using the data but his need to close on certain related aspects without an overview of the total presentation has caused him to give a limited judgment.

5. Extended Abstract

> "The population of this district has declined steadily because of a lack of employment. There is little other employment than crofting and fishing, and the population are seeking a better working community. Park is clearly not a very prosperous area therefore the young people are naturally inclined to move to more prosperous areas, in Scotland and England. Also the area in which houses can be built is very small and as the younger ones grow older they will try to find an area with better prospects for a good house and good living conditions. The island being on the most north-westerly tip of Scotland is exposed to severe gales, rain, sleet and snow in winter, and as the graphs show temperatures are low and rainfall high. This type of weather has caused land erosion and the land is bleak and the topsoil thin and rocky. The possibility of growing many crops is very remote and fishing during the late Autumn period can be dangerous and not worthwhile."

This student's judgment is organised relative to a guiding hypothesis, viz. the general lack of opportunity in the area and the willingness of the younger generation to move. He uses reasoned ideas and relevant evidence from the data to support his argument. His consideration of all the dimensions in the data and their interactions has enabled him to generate ideas or relations outside the data, for example, "Park is clearly not a very prosperous area". This provides a good example of that quality of extended abstract responses where the student shows an ability to abstract the dimensions of a problem and combine them logically to produce an outcome that may not actually be able to be observed or able to be related to experience but which is logically possible.

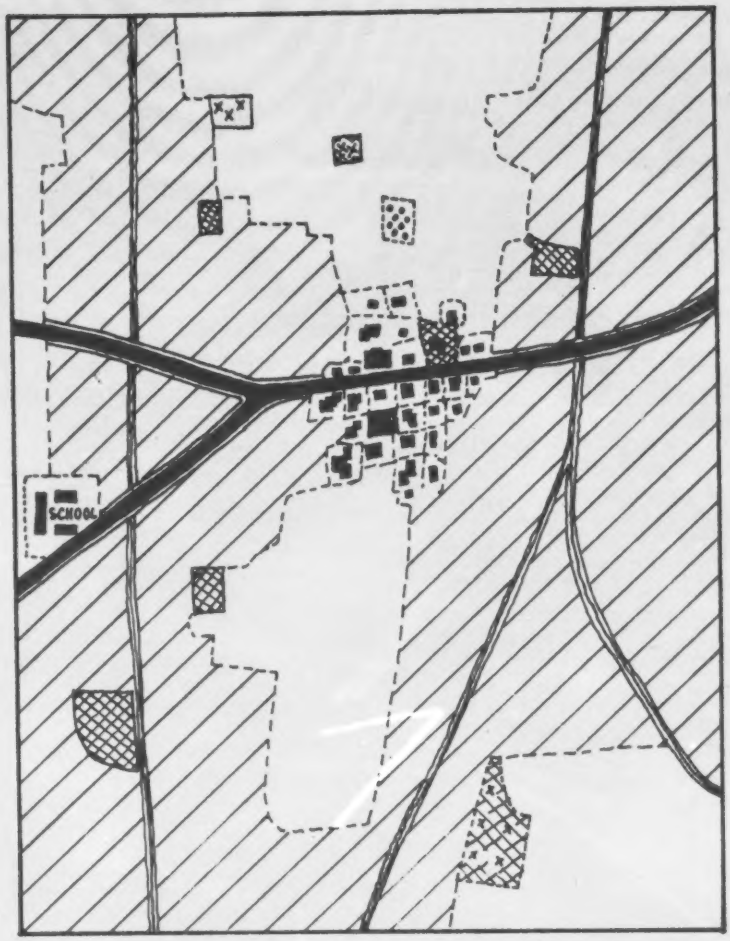
(3) Item 3. Farming around Nara, Japan (Rhys, 1972)

The test material was designed to convey a reasonably realistic picture of an example of intensive subsistence tillage with rice dominant, in an area of dense population. Though rapid industrialization is changing the agricultural patterns within the economy many of the rural communities in Japan retain much that is traditional in the way of self-contained practices, especially in the highland areas where the style of farming is often better suited to the culture than the land. The most serious obstacle in the path of agricultural change lies in the small size of rural holdings, which are no longer economically viable. The questions were designed to contrast those aspects of the traditional rural scene in Japan that are currently succumbing to change with British farming practices.

The test material consisted of the passage set out below, plus the map (Figure 2G) and a photograph illustrating some of the aspects of farming in

Figure 2G

A SMALL JAPANESE RURAL VILLAGE



Source: G.T. Trewartha, Japan, its physical, cultural and regional geography, Methuen, 1948.

rural Japan described above. An atlas map of the islands of Japan was made available to give some idea of location.

> "The tiny village of Nara is situated 20 miles to the west of Osaka on the island of Honshu, the central and largest island of Japan. In this village the farmers live with their houses grouped close together, their small pieces of land being scattered in the fields around.
>
> After the barley has been cut in May, the fields are dug, thoroughly manured and flooded ready for the rice crop. The rice will first have been sown in seed-beds, after being transplanted in June to the main paddy-fields. At this season the fields are busy with men and women working nearly knee-deep in mud and water.
>
> The rice sprouts rapidly during the summer heat when the farmer must keep the weeds and insects under control. By October the crop is ready for harvest, so that during autumn the roads are hedged with sheaves of rice carefully cut with a sickle, and before every farmhouse the womenfolk are busy threshing with flails. As soon as the last rice grain has been harvested the fields are prepared for the winter crop of barley. Meanwhile, all through the year the farmer has been growing on the upland areas vegetables and mulberry bushes (to feed the silk-worms)."

Question 1: "As you have been told most of the work that these farmers do, is done by hand. Why do you think they make no use of machinery at all?"

Question 2: "The British farmer normally lives away from the village with his land grouped around his home in a single piece. Why do you think the Japanese farmer lives in the village with his land scattered in a number of separate places?"

Examples of Responses

1. Pre-structural

Q.1 (a) "Because they haven't invented it yet."

This response provides no indication that the student has accepted the implications of the question in any realistic sense.

(b) "Because they feel they would do it better without machinery."

(c) "Because they think hands are better."

In these two responses the data has not been examined; the students simply assume it is the preference of the farmers. The elements of the problem which are significant geographically have not been recognised.

Q.2 (a) "He couldn't have land round there because the village is there so he has the land scattered."

When the data presented includes a map (or some form of Euclidean representation) responses at the pre-structural level may show a degree of spatial confusion. Because he does not make a realistic analysis of the

map, the student tends to react to a perceptually dominating feature (in this example the centralized and structured nature of the village) and to base his explanation on that feature.

(b) "They might think it better to have it scattered. They might not like a big field and would prefer little ones."

This response shows a failure to relate the question to the information in a realistic way. The student assumes that the reason is the personal preference of the farmer.

2. Uni-structural

Q.1 (a) "They can't use it in mud and water, the machines would sink."

(b) "Because it is too wet on the ricelands and the machines would get stuck in."

These responses show that the students' thinking at this level is dominated by the most obvious piece of visual evidence - the flooded ricelands. They have perceived one dimension of the problem and then made a decision, i.e. required closure.

Q.2 (a) "Because some pieces are by the river and he needs the water for his rice."

(b) "Because in different pieces of land he grows different types of crops because some soils are different to others."

(c) "Because the ricefields are wet and if the houses were there they'd get flooded."

(d) "They divided it like that because there are so many people in Japan."

In each of these responses the student considers a single aspect (which is perceptually dominating for him) from the data and gives his reason using only this aspect to support his decision (closure). He has used the data to find one positive benefit or reason to explain the land distribution.

3. Multi-structural

Q.1 "The farmers are too poor." (Why do you think so?) "They've only got a little bit of ground and they'd only get a little bit of money for their crops, and there wouldn't be enough to buy machinery."

This student has considered two relevant dimensions before making his decision but his response is restricted to certain aspects of the data which are unrelated. He has closed on these aspects and thus the deduction he made is limited.

Q.2 (a) "Its scattered because he has to take what land he can get. He has two pieces near the drainage channels, and others in dry areas where he's got vegetables and mulberrys, because he can't grow anything else."

This student's response is bound by the content of the situation. He sees the map as providing information about one man's farm and thus he makes a limited inference, "he has to take what land he can get". The student has attempted an analysis in terms of the data but because he is bound by the data and his initial point of view his interpretation is incomplete.

(b) "The farmer probably bought them at different times and he wanted some from each place. You can only grow rice in a certain area and he probably wanted some dry crops as well. All the pieces are placed near drainage faciiities and roads."

Similarly this student has chosen a point of view "he wanted some from each place" and he has then used the data to support this reason. He accepts the map as representing the situation as it has always existed because he is unable to go beyond the data to consider the effects of geographical conditions. Because he is unable to look outside the material given and does not inter-relate that adequately his interpretation is very limited.

4. Relational

Q.1 (a) "Machinery would be very difficult to transport over those lands and would get bogged down, and the majority of farmers would be unable to afford it. There's a limit to what a man can do by manual work and I doubt if he would make a very large profit or be able to afford the machinery."

This student has considered a number of dimensions of the data, but he has confined himself to the material presented. He is able to generalize but has done so on the basis of a few pieces of evidence only, for example, "there's a limit to what a man can do by manual work and I doubt if he would make a very large profit". His generalizations reflect personal viewpoints rather than a consideration of geographical aspects of the situation. He has generalized from the concrete content of the material while allowing his thinking to be bound by his personal experience. This response has a similarity to the uni-structural and multi-structural level examples in that his answer is biased toward the rice areas rather than being an examination of the total environment. However, when students responding at this level were asked about the dry crop areas they were able to incorporate a discussion of these in their answers.

(b) "If all the land here is flooded you wouldn't be able to use machines. There's plenty of labourers there because Japan is a pretty crowded place. They can use their hands to pull it out by the roots, it prevents any damage and does the job better."

This response provides a good example of how a student operating at the relational level can look at the dimensions and their relationships as represented in the data. However the decision (closure) is made without taking an overview which would allow the dimensions and their interactions to hold simultaneously. Thus the judgment is limited to certain aspects of the situation. This response also reflects the tendency of the student responding at the relational level to approach the question with the assumption that the existing situation is the only possible occurrence as opposed to the approach indicated by the extended abstract response, which, in holding the question open, views the situation hypothetically and allows all the possible outcomes to be canvassed. Thus at the extended abstract level of response, the point that the situation depicted may reflect traditional practice rather than the only possible economic development can be considered.

Q.2 (a) "Well, they couldn't build the houses in the rice fields anyway so they probably decided to build centrally so that they were all near the shrine and the main road and then they decided to use the rest of the dry crop areas for whatever was the most suitable produce."

This student has based his explanation on the assumption that Japanese farmers would prefer the English situation and has generalized from the data with that limitation imposed. He has failed to view it as a totally new situation and has failed to analyse it in terms of the limitations it provides. The student is capable of generalizing from the data to provide an explanation, but is not capable of viewing the new situation hypothetically, free from the restrictions of personal experience.

(b) "Since the land has been acquired over a long period of time the farmer has acquired a number of separate plots. He probably built on dry ground near his first plot and as the need for more food became pressing they all expanded outwards but kept their houses in the original place. Land became scarce; you can see they don't have a lot around their houses. Also it says there is plenty of labour so each plot could be farmed by a different person so the one farmer wouldn't have to travel between plots during the day, and if they live centrally they can decide each morning where to go."

The student has considered a number of aspects of the situation and has made some very interesting generalizations about these, for example that the large labour force can be easily divided between the plots. He has considered the logical possibilities within the problem but he has not considered the simultaneous interaction of these. Each point has been considered and discussed separately, thus he has not realized that the Japanese must maximize food production by making best use of the land

available. It is interesting to note that even at this level of response the student is bound by the data to the extent that he sees the village as "central" and is unable to visualize farming in rural Japan as a widespread policy of farming all possible land in the most productive way as evidenced by their terraced hillsides and the practice of carrying top soil to the poorer sections.

5. Extended Abstract

Q.1 "Because there are so many people living on the island, machines would put a great number out of work, and there would be much unemployment and greater poverty than now. They can use more people and accommodate most of the people in Japan by this traditional way of farming. Machines haven't been invented to sow rice efficiently and to plough the paddy fields. Weeding and insect killing is done by hand for the same reasons. There would be a lot of problems involved in getting machinery up to the dry crop areas and operating successfully on the rough ground and small fields. The cost of machinery to the farmer may also be prohibitive."

The traditional pattern of land use, the nature of the terrain and the dense population form the core of this response. In considering dry crop areas as well as the rice fields it has spanned the whole spatial field. The introduction of the concept of redundancy illustrates the ability of the student responding at the extended abstract level to consider the interaction of the dimensions of the problem situation and thus generate relations outside the data. Within the limits set by personal knowledge and the amount of information available within the test situation this student has succeeded in achieving a balanced, carefully reasoned and objective judgment.

Q.2 "Because of Japan's dense population and small amount of arable land sufficient food production is a problem. All the land that can possibly be used is needed for farming. The Japanese even terrace the hillsides and grow up to three crops per year in the same soil. So one of the reasons for having the houses altogether is that they are probably all built on the poorest soil and the living area is kept as compact as possible to allow more land for farming. The Japanese farmer's land is scattered partly because the family may have acquired it over a period of time, and also it allows each family unit to farm a range of crops. Since the only irrigation is drainage channels each farmer can have some land near the channels for rice-growing and some further away for a variety of dry crops. Scattered plots also means there is a more equitable distribution of good and poor land. Traditionally each family, including the wife and children, farms the family land so having it in small plots is not inconvenient even though at first it may appear to be."

By considering the facts and implications of the situation simultaneously the student has looked at the total situation in a reasoned way and thus produced an explanation that can be supported by the specific pieces of evidence. He has viewed the question, not from his own experience, but from his knowledge and imagination of the needs and traditions of the Japanese people. A student responding at the extended abstract level may orient himself culturally as well as spatially, so his approach is an open one; by considering the interaction of factors his response goes outside the data to give a logical explanation.

(4) Item 4. Wheat Farming, Grong Grong, N.S.W.

Data gathered from local high schools in N.S.W. provides supporting evidence that qualitative levels in children's responses to geographical material can be identified, and that these levels provide a meaningful indication of the maturity of judgment and understanding of the pupils. In general, the majority of responses obtained from junior secondary students (12-16 years) were at the levels of uni-structural, multi-structural, or relational. However a disturbing number of pre-structural responses was obtained and only a small proportion of the responses was judged to be at the extended abstract level. This last finding is in accord with published research which has reported that it is not until an age of 16+ years that most students respond to geographical material requiring deductive reasoning ability at the extended abstract level.

In the following test item a small town, Grong Grong, in the N.S.W. wheatbelt was chosen because it lies in a vast plain on both road and rail routes. The students (12-17 years) were shown:

(i) Several pictures of the land around Grong Grong illustrating the vast flat plain, the wheat farming industry and early transport and communication links provided by Cobb & Co.

(ii) A map of N.S.W. recording the wheatbelt, the major railways and the major towns and rivers surrounding Grong Grong. The latitude and longitude of Grong Grong were also marked (Figure 3G).

(iii) A plan of the town showing both road and rail routes (Figure 4G).

The question asked was:

"Why did this small town develop just here at the intersection of railway and road routes in the N.S.W. wheatbelt?"

Figure 3G

NEW SOUTH WALES WHEAT BELT

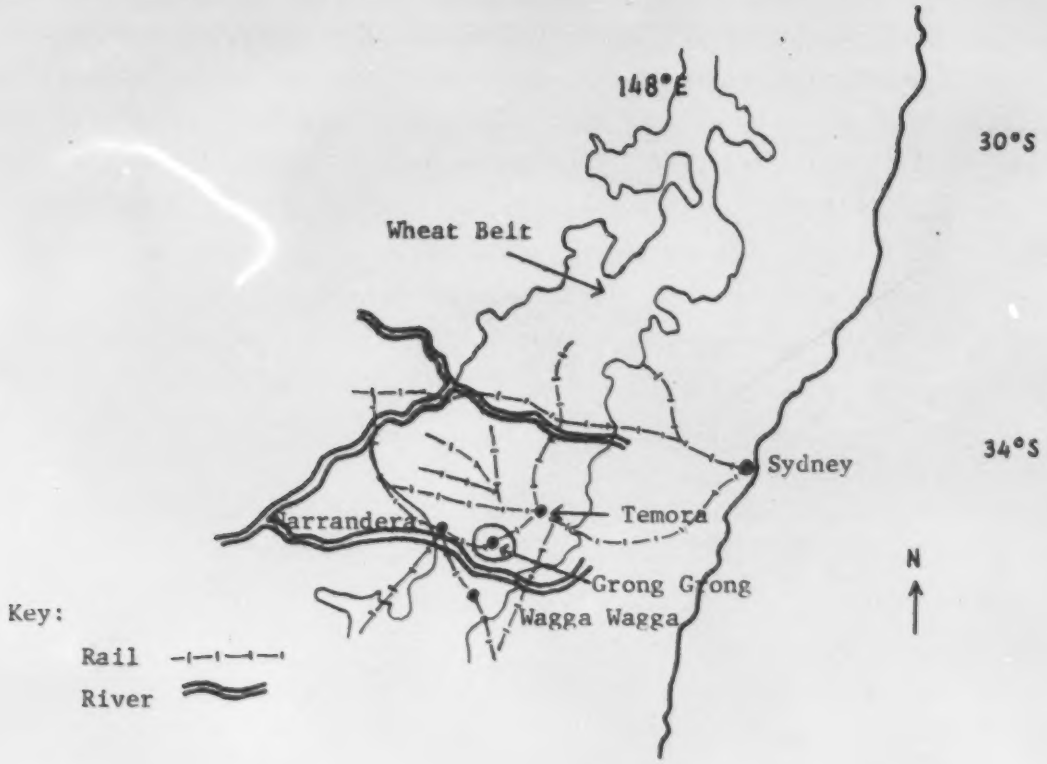
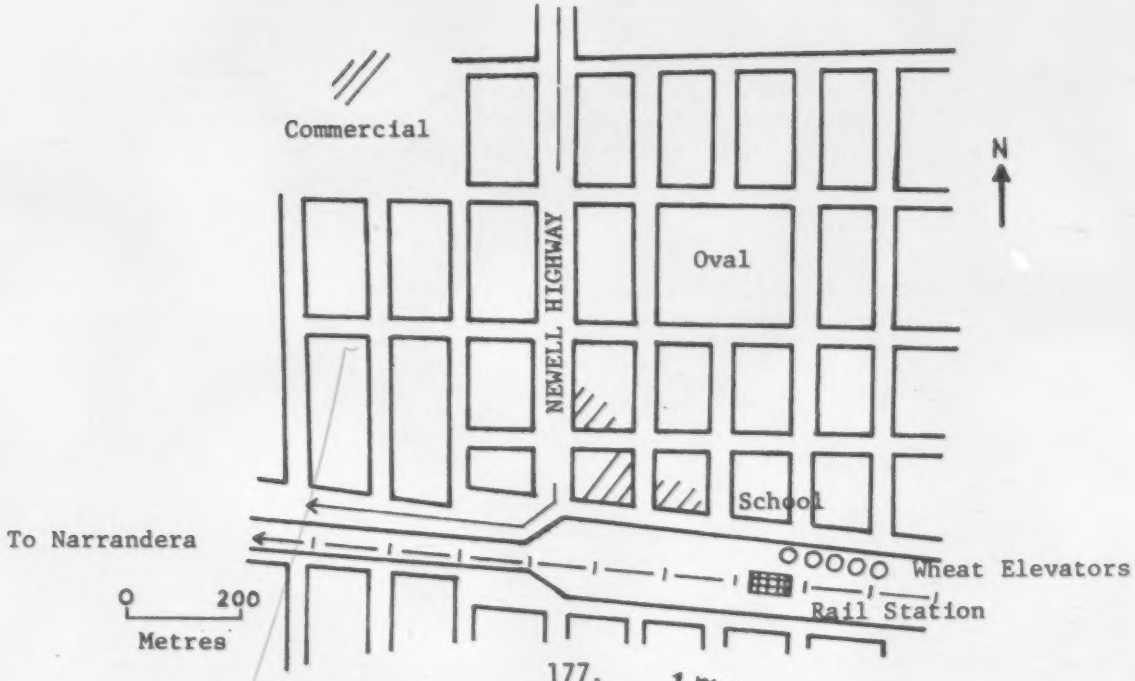


Figure 4G

GRONG GRONG N.S.W.



Examples of Responses

1. Pre-structural

With data of this kind (maps) the main characteristic of pre-structural responses is lack of spatial orientation and this usually occurs in younger pupils. With children under 10½ years responses of the type "it makes it easier to go there because it is in the middle" have been noted. At this age children are unaware of the extended frame-of-action. With the students questioned here the simplest responses were at the uni-structural level, e.g. "Because they had transport by road and rail". Since the students were 12 years and older pre-structural responses reflecting lack of spatial orientation were not expected or obtained.

2. Uni-structural

(a) "The town developed here because of the ease of transporting the wheat." (12 years)

(b) "The surrounding land is good for wheat growing and so the town developed in the centre of the wheat growing area." (12 years)

(c) "The highway and the railway meet making it easy for transport." (12 years)

In each of these responses the student has chosen the dominating concrete evidence provided in the data. Students operating at the uni-structural level tend to give only one factor and not a combination of factors. This uni-dimensional perception means that if they see the advantage of the town as transporting wheat out of the area they will not consider the advantage of the town as a distribution point of goods into the surrounding area.

3. Multi-structural

(a) "The town developed here because the surrounding area provides good conditions for wheat-growing and the railway and the road provide ease of transport." (13 years)

This response takes two un-related but relevant facts and makes a decision on this basis.

(b) "The town developed there because of the availability of transport for moving the wheat and also to meet the needs of the farmers supplying goods and equipment." (14 years)

This student shows an understanding of the reciprocal nature of the transport system. He can see from the pictures that the wheat farmers use heavy equipment and he has realized the need for a central distribution point within the wheat district. This response could be regarded as transitional, i.e. 3A, in that there is a hint of seeing an inter-relationship between

two facts. The attempt is spoilt by the student's tying himself to one aspect only, transport.

(c) "The flat country means the surrounding area is good for wheat farming and there is plenty of water so the town developed in the area but near the road and rail routes so that there was convenient transport. Also the town is directly linked to Sydney." (13 years)

Multi-structural responses typically show that the students see a number of factors operating. However they are bound in their judgment by the content of the data and so their comments reflect the situation as it is presented; they are unable to visualize it as it developed. Thus, for example, they see the road and rail routes as existing before the people came to the area. They do not see that the growth of the area is dynamic with some factors reinforcing others or that the town's development reflects the interaction of factors.

4. Relational

(a) "The first people there built a house around the rail and road and others built around them. There was ease of travel from and to the town due to the rail and road. Transport of goods was easier to and from the town to other markets. There was plenty of work available on the wheatbelt and this attracted a large population." (15 years)

This student is capable of generalizing from the data but his perception is limited to the situation as it is presented. He is unable to free himself from this and imagine the area's development from the earlier days. He has considered each of the factors and some interactions. That he is still bound by the data is evident in that his explanation is based on the assumption that everything was there and then the people came.

(b) "The town developed here for a number of reasons. It is near road and rail routes for (a) transporting food, machinery and other goods into town and (b) transporting wheat to bigger wheat centres and markets. The position inside the wheat-belt indicates good conditions for wheat growing rather than marginal. The town looks similar to a lot of towns e.g. Woy Woy where the main shopping centre has developed near the railway. Also some wheat workers would prefer to live in a town where services and recreation are available." (15 years)

This student has discussed all the factors that can be obtained from the data. He is capable of generalizing from his experience, for example the sentence "The town looks similar ..." His answer is limited only by his failure to view the town's development as a growth situation determined by the geographical factors of the area. This student also sees the road and rail routes as existing before the area placed a demand for them. The

student responding at the relational level uses the data and perhaps some personal concrete experience to form generalizations, whereas the extended abstract level response shows that the student has looked at the total situation and used the data to test or support hypotheses.

5. Extended Abstract

> "There had to be a central place where all the produce from the area could be sent to be transported to markets. This would be a good place because a network of railways and roads has developed enabling farmers to take their produce to the railhead where it could be transported cheaply in bulk by rail to markets. Once the rail station had developed and was used by the surrounding farmers as a way of sending out produce and receiving goods such as food, farm machinery and fertilizers the junction would need to provide additional services, e.g. a service station to provide petrol, a post office and general stores. As these services grew other services would be needed to provide for the families of those persons providing for initial ones, for example schools, shops and medical services. As these became established people would come and settle in the town with no intention of farming but just to provide services for the agricultural initiators. If the agricultural use of the area died, the town of Grong Grong too would decline as it is only a service centre for its hinterland. If the hinterland initiated no demand then the services offered by the town could not be sustained." (16 years)

This response shows an understanding of the system of relationships and the interaction of factors that contribute to the economic growth of an area. The town's development is seen as both contributing to the area and benefiting from the area, and this interaction helps its development. This student has used the data to support his well-structured deductive argument, whereas the students responding at the lower levels quote the data only. The last two sentences of this response illustrate the extended abstract characteristic of taking into account a hypothetical situation and its possible outcomes.

(5) Item 5. Picture of Countryside

Test items using simpler data have also been used. In the items considered previously in this section on Geography, data has been presented in the forms of verbal descriptions; diagrams; descriptions, photographs and maps; and pictures and maps. In the following item the only data presented to the students was a colour photograph of a rural scene. Students (aged 6-14 years) were asked to look at the picture, find three different things in it, and make up three separate sentences, one about each of the observed things.

Examples of Responses

1. Pre-structural

(a) "The picture is boring to look at.
The picture is about the country.
There are trees like the trees in Newcastle."

These sentences did not occur in the sample investigated, but indicate the kind of response which would be expected at the pre-structural level. They do not contribute to an understanding of the picture in geographical terms. The first sentence is an example of denial. The student is simply refusing to take a serious interest in the task. The second sentence is possibly tautologous - certainly it would be had the student been told he was to look at a picture of the countryside. The third sentence could exemplify a confusion of transduction: the response could indicate something of geographical significance, but what this could be is not evident in the response and is probably an irrelevant association in the student's mind with familiar trees in his home environment.

2. Uni-structural

(a) "There is a creek with water.
The trees are orange.
There are cattle on the grass." (6 years)

This is a typical response at the uni-structural level in that each sentence expresses only one dimension of the thing that is observed. There is, for example, no attempt to see the creek in relation to other features of the landscape, or to indicate why the trees are orange.

3. Multi-structural

(a) "The cows in the field are grazing.
In the background there is a forest.
The trees are very colourful." (6 years)

In this response the student describes a number of relevant data in connection with the thing observed. The cows are not seen merely as being "on the grass", but are seen as being located in a more definite area of the picture ("in the field") and are seen as being actively engaged in grazing. In the second sentence the forest is not only observed, it is also located in relation to other parts of the picture in that it is described as being in the background. The third sentence appears typical of a uni-structural response but has been classified as multi-structural because the response implies a higher order processing; "colourful", for example, takes into account more information than simply selecting the most prominent of the autumn tonings, "orange".

4. Relational

(a) "There are trees around the edge of the water to stop erosion of the soil.
The trees and the river are boundary lines for the cattle.
There are lots of houses around in the gully."

Here the response indicates that a number of factors are being taken into account and are being related to each other in a rather elementary way. In the first sentence, for example, the relationship between the trees, water, and soil is expressed in terms of erosion. In the second sentence the relationship between trees, river, and cattle is expressed in terms of boundary lines. The third sentence fails to make any relational observation in the way indicated in the first two sentences; it is a response at the multi-structural level. The three sentences taken as a whole represent a low level (or perhaps transitional) relational response.

5. Extended abstract

(a) "The large trees on the river bank, photographed in autumn as is indicated by the yellow foliage, appear to be non-indigenous in contrast to the typical Australian eucalypts higher up the slopes, which implies importation by migrants some time ago.

Although the topography is nowhere particularly rugged agriculture is restricted to the low lying land near the river, which suggests one or both of such factors as low population density or high yield per worked unit area, thus allowing the settlers the luxury of farming only the most easily exploitable land.

The distribution of dwellings indicates farming land located on the edge of an urban area, and a likelihood that the cattle seen grazing in the paddocks are farmed for dairy produce."

In an item of this kind, where the response is limited to one sentence, there is plainly a reduced opportunity of responding at the extended abstract level. Nevertheless these examples, not taken from the sample investigated, show the kind of response that could be expected at this level. Each sentence identifies a variety of factors, indicates possible systematic relationships between them, in one case (the second sentence) provides alternative possible explanations or hypotheses, and makes use of abstract concepts and principles in giving an account of the phenomena under consideration.

(6) Item 6. Physical phenomena: Why does it get dark at night?

In this item no data was supplied to students since the subject matter would be familiar to all students as a matter of common experience, that is

the difference between night and day. The purpose of this item was to investigate the kinds of explanation that students would provide of the commonly experienced fact that darkness occurs with nightfall. Accordingly the item comprised only the simple question: "Why does it get dark at night?" Students aged 9-13 years were asked to answer the question.

Examples of Responses

1. Pre-structural

(a) "So we can sleep." (12 years)

(b) "Because they have to sleep." (13 years)

(c) "Because the clouds come dark and change." (11 years)

These responses clearly give reasons which are irrelevant to the question. The fact that it is normally convenient for people to sleep at night provides no explanation of why night falls. The third response perhaps indicates a confusion due to transduction in that the student seems to have associated nightfall with the darkening caused by clouds interfering with sunlight.

2. Uni-structural

(a) "Because the sun goes down in the afternoon." (12 years)

(b) "Because the sun goes to the other side of the world." (11 years)

These two responses show that the students are aware of one dimension in the explanation of nightfall: both responses indicate that darkness has something to do with the positions of the sun and the earth. However, there is no awareness of other important factors relevant to the explanation, such as the rotation of the earth.

3. Multi-structural

(a) "Because the sun has turned and it shines on the other side of the world." (11 years)

(b) "Because the earth is spinning and the sun is going round the earth." (11 years)

A number of factors is taken into account in these responses: the positions of the sun and earth, and the behaviour of these bodies - or at least one of them - is described by the students. The second response is better than the first in that it mentions the rotation of the earth, whereas the first seems to consider rotation ("turned") but attributes this to the sun rather than the earth. In terms of the level of response, however, this is not important; what is important is that both responses indicate an awareness of a number of factors which are relevant to the question but the factors are not necessarily specifically related to one another in the response.

4. Relational

(a) "Because the world moves around when it sunny or daylight it is dark on the other side of the world. When it is sunny the sun is shining. The other side is shaded by the other side of the world." (11 years)

(b) "It gets dark at night because the sun goes round the earth once for 12 hours and for the other 12 it is night time and the sun is around the opposite side of the earth and that is why it gets dark." (12 years)

Both these responses show an attempt to relate the different factors involved in the explanation, rather than merely to list the factors. Neither employs explicitly a relational term, but the descriptions given show that an attempt is being made to explain darkness on one side of the earth in terms of a relationship between the sun, the side of the earth facing the sun, and the side of the earth facing away from the sun. The second response elaborates on this by introducing the element of time in relating the rotation of the earth to a 24 hour cycle divided into two 12 hour parts, in one of which there will be light while in the other "it is night time".

5. Extended Abstract

(a) "The earth is roughly spherical in shape and rotates about its north-south axis. At a great distance away from the earth, and very approximately at right angles to the axis of rotation of the earth, is the sun which acts as a point-source of light. This light travels in straight rays. Consequently, at any one time the half of the earth's sphere facing the sun will be in light while the opposite half will be in shadow. Since the earth is rotating continuously, a point on the earth's surface will pass alternately through the lighted half and the shaded half. The duration of a rotation is 24 hours, so the point will be in daylight for 12 hours and in darkness for 12 hours. The period of darkness is called night. This account is a little simplified, in that it ignores the fact that the axis of rotation of the earth is tilted at 23½° from the plane normal to the sun's rays. Consequently the length of day and the length of night will not be equal for a given point on the earth's surface; this is further complicated by the earth's revolution around the sun once in a year. However, these considerations affect only the relative lengths of day and night at a particular point on the earth's surface at a particular time of the year."

Although this example is not taken from the responses obtained in the sample, it indicates the kind of response which would be expected at the extended abstract level. The response displays an awareness of an extended range of factors necessary to an adequate explanation of the phenomenon in question. It shows how these factors inter-relate and makes use of

abstract concepts (such as "a point-source of light"), which are not present in the question, to do so. That is, the response goes beyond the obvious factors raised by the question itself (such as the earth and the sun) and resorts to an extended range of reasoning and principles in order to provide an adequate answer to the question.

A Summary of Further Relevant Research in Geography and Social Science Education and its Relationship to the SOLO Taxonomy

Most of the investigations into children's thinking and the development of their ability to reason and make judgments in school Geography and Social Studies have tended to look at a specific skill (e.g. map reading ability) or the growth of understanding of specific concepts (e.g. nationality). While these studies have limited generality, they may be of interest and relevant to specific work units in the Geography curriculum.

(i) Stages in the Understanding of Specific Concepts

Jahoda (1963) tested children's understanding of the inclusion relation "Glasgow-Scotland-Britain". The subjects were between 6 and 11 years of age and were residents of Glasgow. He found four easily identifiable stages in the child's capacity to grasp the concept. The concept was tested using both verbal interviews and by asking the children to demonstrate the relationship using concrete material. Both sets of results provided evidence of stages in the children's understanding, and even though there was a marked variability the majority of children did not demonstrate understanding of the relationship "Glasgow-Scotland-Britain" until 9-11 years of age. The results showed that children from middle-class districts demonstrated understanding at an earlier age than children from working-class districts, but when these children were matched for I.Q.'s this difference was much less significant. Overall, the results are essentially consistent with the SOLO Taxonomy. At the multi-structural level (approximately 10-12 years of age) pupils would be expected to be able to consider the three items of data in this relationship.

Jahoda also tested children's understanding of the concepts of "large town", "country", "nationality", and "national symbols". His results supported the general view that children begin with an awareness of their immediate locality which then becomes progressively extended outwards with a sharpened discrimination concerning such geographical terms as "town" and "country". The outstanding feature of these studies is that between the age of 6 years and 11 years the child progresses from a state of almost complete

ignorance about the wider geographical and social world to an outlook that is not fundamentally different from an adult's. An analysis of the data as a whole indicated that the central process is the way the child differentiates and orders ever-widening sections of his geographical environment. Jahoda stressed the enormous variability among the children tested over the stages. He suggested that one important teaching implication is to plan the curriculum so that the lesson content proceeds from the immediate vicinity outwards - from the home town to the country as a whole. The SOLO Taxonomy provides a more detailed basis for the structuring of this curriculum. As attention is extended from the immediate vicinity outwards lesson content would increase, and this content should be organized in such a way as to be compatible with the levels of development of the pupils learning the material. More specifically, pupils whose responses are at the uni-structural level should be given material which enabled them to master relatively simple information which related to their immediate vicinity while encouraging them, by questioning, to respond to more than one aspect of the given information. The pupil's development through the multi-structural, relational, and extended abstract levels of responding would be matched by an increase in the complexity and difficulty of the subject-matter as it included increasingly wider ranges of information.

Marsh (1966) followed up the work of Jahoda by comparing two groups, city children and country children. The subjects were matched for age, intelligence and socio-economic status. The concept tested was the relation "Aberdeen-Scotland-Britain". The results showed that rural children were significantly more advanced than urban children in their attainment of the concept of the relationship between Aberdeen and Scotland, but not in their understanding of the Scotland-Britain relationship. Her research also indicated that in many cases, apparent verbal understanding in the interview was not backed up by correspondingly well developed spatial concepts. This adds support to the opinion that often children can verbalize fluently without true conceptual understanding. Naish (1972)

Lunnon (1969) tested the understanding of certain geographical concepts (river, mountain, beach, farming, trade, desert, season, soil, cloud and map) in children aged 5 to 11 years. He found that the growth in understanding of these concepts occurred gradually, and that it was more closely correlated with chronological age than mental age. Children whose parents were in the highest socio-economic group performed much better in both the

verbal and pictorial tests than those whose parents were in the lowest socio-economic group: the differences were much more marked in the verbal than in the non-verbal tests. The use of non-verbal tests revealed that children often have a concept of a farm or a beach, for example, long before they can explain verbally what a farm or a beach is.

Milburn (1972) pointed to the need for text-books to be more carefully graded in the concepts which they present to the pupils. He investigated terms used in primary and secondary geography text-books in England and he noted that about half of the terms introduced were not defined and that there seemed to be no clear rationale behind the introduction of a term at any given stage. In view of the evidence that the child progresses through developmental stages in the acquisition of concepts, authors should aim to help students build up a structure of concepts by being aware of the cognitive hierarchy within their discipline. The SOLO Taxonomy helps to provide a structure within which the teacher could organize material of appropriate complexity and difficulty for pupils at different levels of cognitive development.

Vass (in Graves, 1975) attempted to find out whether it was possible to determine the age at which the teaching of physical geography could be fruitful because children had acquired many of the basic descriptive concepts. He showed that there was a steady growth in understanding of certain basic concepts in physical geography from eight to fifteen years; but he was unable to suggest a certain optimum age at which to begin the teaching of physical geography. He found that concepts which encapsulate a variety of more simple concepts are difficult to acquire, for example, "relief", as applied to the landscape, and "drainage". Data of this sort would be valuable when used in conjunction with the SOLO Taxonomy in geography, since it suggests that transitions from one stage to another might not be of equal difficulty: e.g. the move from multi-structural responses to relational responses might be expected to be of greater difficulty than the move from uni-structural responses to multi-structural responses. In the light of these considerations lessons could be planned which matched more adequately the level of cognitive development of pupils in allowing, for instance, more effective use of the "plus one" strategy.

Jurd (1975) designed a study to analyse the logical operations involved in thinking about the two concepts "minority" and "poverty" in secondary school Social Science courses. The test items were grouped:

(a) definitional and categorizing

(b) correlational

(c) situational.

Items in the first group were designed to assess the student's ability to categorize consistently according to a given definition. The second group of items tested the student's understanding of the concepts in association with other related concepts, and the third group of items was designed to test understanding about current issues related to the concepts of minority and poverty. Her results provided support for the view that there is a developmental sequence in thinking about these and similar social science concepts.

A study that is relevant to some aspects of the Social Studies curriculum was conducted by Koocher (1974). He identified three levels of thinking in children to parallel Piaget's stages of pre-operational (or pre-structural in terms of the SOLO description), concrete operational (uni-structural, multi-structural, and relational), and formal operational (extended abstract) thinking, about their concepts, of "self", "ideal self" and "others". Pre-operational children did not see others as different from themselves, and ideal self was viewed as being significantly better than both self and others. Concrete operational children significantly differentiated among others, self and ideal self, and saw them as being increasingly better in that order. Formal operational children were approximately equally divided as to who was better, self or others, but perceived a greater gap between these and ideal self. Also older subjects showed greater agreement about the term "ideal self".

(ii) Stages in the Growth of Specific Skills

There is general agreement among researchers that there are stages in the development of a child's perceptual ability and the development of his spatial concepts, but that skilled teaching and a structured programme are necessary to aid this development. Boardman (1976) suggested that in the study of maps and photographs beginning with a large scape map of the local area and subsequently progressing to other maps with ever-decreasing scales provides a well structured progression for the primary to junior secondary school student. The use of carefully selected photographs can help the pupil's understanding of the complex reality which lies behind the map. Prior (in Graves 1975) found that while children are operating at the concrete level (the uni-structural, multi-structural, and relational levels in SOLO terms) the kind of map information which they can use is limited to that representing areas or landscapes with which they are familiar.

Haemon (1973) carried out a series of experiments in which he tested primary and secondary school children's ability to (a) generalize distributions on maps, e.g. the distribution of built-up areas on a map, (b) compare two distributions, e.g. the distribution of woodland in relation to other features (for instance high ground). He found that the older children (12-14 years) were better able to represent the outline of, say, a built-up area on a map, than younger children and also much better at seeing the connection between two distributions. This in part may be determined by the tendency for younger children to examine micro-features on a map rather than macro-features and to remain unaware of apparently significant correlations between two patterns which may be quite evident to an adult. This progression in level of response can be seen to parallel that described in the SOLO Taxonomy.

Towler and Nelson (1968) tested their subjects' (grades 1 to 6) concepts of scale, and identified three levels in the development of this ability. They found pupils about 9 or 10 years of age could use a scale meaningfully, but that comparing maps with different scales (e.g. a map with an enlarged inset) should not be introduced until the pupils are about 12 years of age. The growth of understanding of scale was correlated with both chronological age and with intelligence, but school experience was seen to be an important factor in the development of the concept.

Sandford's (1972) research has shown how many children at both secondary and primary levels are unaware of the limited nature of map information, so that they either make unwarranted inferences or assume that a map shows all that is known of the area.

Graves (1975) points out that large-scale maps (or aerial photographs) of the home or school area may be understood by upper primary school children, but that maps of other areas on a large or small scale will only be meaningful when spatial conceptualization and mental development have advanced into the stage of formal operational thinking where extended abstracted responses in this content area may be expected. This places emphasis on the value of using a map "in the field".

In summary, it seems that the SOLO Taxonomy provides a useful structure in geography within which to

1. Identify pupils' level of cognitive development and plan lessons accordingly.
2. Analyse the curriculum into types, hierarchies, and sequences of content appropriate to the pupils' level of cognitive development.

3. Test pupils' learning in terms of the SOLO levels and adjust teaching accordingly.

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APPENDIX

SECTION C - GEOGRAPHY

Note on the presentation of data in the Test Item "Crofting on the Isle of Lewis"

Many geography teachers would find this data presentation unacceptable on account of its cartographical and logical deficiencies.

The lack of scale and direction on the British Isles Farming map, together with inadequate delimitation of the map area, and the fact that the district in question is in a form of shading not shown in the key, mean that the students were making assumptions rather than deductions. Similarly, in the larger scale sketch map (untitled), it is not clear whether the Park District includes both the Common Pasture, and the Deer Forest and Rough Grazing. If only the first, then the name "Park" in the second area is simply confusing: if both, then there is a lack of correlation with diagram (i) "Composition of the entire area", of the Land Use 1958. The use of a continuous line for the boundary between the two areas, and a dotted line (not featuring in the key) between the Common Pasture and the "Island of Lewis", further complicates any decision as to what constitutes the area of the Park District.

The use of "equals" instead of "represents" in the scale of the live-stock histogram is completely unacceptable at any level, while the use of climatic data such as these graphs (without any indication that they are the usual ten year running averages of mean monthly figures) is certainly inappropriate for the younger end of the age group. The quotation in example 2 of Concrete Generalizations, "... it is considerably colder, the maximum temperature being about 57°", is not a statement which can be deduced from these data, as mean monthly temperatures are abstractions whose relation to actual daily maximum and minimum temperatures is not given.

At best, this data presentation is an example of "more noise than signal"; at worst, it demonstrates the dangers of an inadequate conceptual basis in map and graph work.

Note: These comments, for which the authors are very grateful, were received from Mrs. S. Grosvenor as a result of the authors' sending out first drafts of the various sections of this report for constructive comment by a variety of people who had special knowledge and interest in

particular content areas. Despite the deficiencies of the item, pointed out so lucidly above, we decided to retain it in the final report for two reasons. First, the responses given by the students fitted the SOLO structure and the criticism is really directed at the original study rather than our analysis of the responses. Second, by publishing both the study and Mrs. Grosvenor's critique we would reinforce our theme that designing a curriculum in a content area along SOLO Taxonomy lines requires a genuine co-operative effort from several specialists working as a team. Not the least important member of that team would be a content specialist with an in depth knowledge of the discipline concerned, a clear view of how the discipline can be used as an educational tool and experience in teaching children.

EXAMPLES OF THE TAXONOMY IN USE

5. MODERN LANGUAGES

Section C: Examples of the Taxonomy in Use

5. Modern Languages

This section provides some examples that illustrate SOLO levels of responses by students working in Modern Foreign Languages. It is designed to emphasize the value to the teacher in recognizing levels of cognitive functioning in students, as indicated by the quality of their responses. This can be useful for a number of reasons:

(i) It provides a method of approach for remedial work with individual students.

(ii) It enables the teacher to recognize when it is necessary to adjust the presentation of class material, making it more concrete or introducing more abstract concepts, depending on the levels at which the students are responding.

(iii) It provides criteria to assist the teacher in recognizing various levels of logical functioning, and then to structure the questioning to encourage responses at a higher level.

Some specific characteristics of children's responses at the uni-structural, multi-structural, relational, and extended abstract levels that are appropriate to the study of modern foreign languages in a classroom situation can be drawn from the more general differences between these levels as outlined in Section A.

Thought processes as indicated by the child's responses at the uni-structural, multi-structural, and relational levels (pre-extended abstract levels) are based on the child's current or recently prior experiences and thus his thought processes, although logical, appear to form a limited system bound by his concrete reality. This means his thinking about new material is based on, or related to, his previous experiences. Thus the student who is responding at pre-extended abstract levels will approach the learning of a second language by attempting to relate it directly to his native language. Another aspect of these levels of response is the need to make closures (multi-structural level), or at least to have a guarantee of closure (relational level). At these levels the student's requirement for closure is revealed in foreign language study by his need to see that for each word in his native language there exists in the second language a matching word that corresponds in every way (e.g. literal meaning, connotative meaning, part of speech, position in sentence). In effect the student assumes a direct one-to-one correspondence between his native language and the foreign language. At the relational level, although the

student may be able to handle more generalized elements, for example, two words for one or a different order, the approach of correspondence between languages still underlies his response. Although language teachers hasten to dispel this belief, in situations where the student is in doubt about a concept or struggling with some aspect of language learning, he will tend to fall back on this approach because the need for closure and the need to relate his learning to his previous relevant experience (i.e. his own language) underlies his current level of response.

In contrast, the student responding at the extended abstract level is capable of thinking hypothetically, of holding his approach to a new situation open (i.e. not basing it on previous experiences) and of handling abstract or variable elements. Thus the response at the extended abstract level indicates acceptance of the fact that words in one language may not have exact equivalents, indeed any equivalent, in another language; the student responding at this level can view phrasing or sentence structures in his own language as relative not absolute, thus he can approach the second language as a different system to his own.

This contrast between responses at the uni-structural, multi-structural, and relational levels on the one hand, and at the extended abstract level on the other hand, in modern foreign language study can be illustrated by students' translations of idomatic phrases. By assuming a direct one-to-one correspondence between languages, the pupil who is responding at the multi-structural level will generally give a direct literal translation of the idiom; the next level of response, relational, shows a similar preference for literal translation but the response shows that the student has attempted to generalise the response into a form which fits the immediate context better. In contrast the pupil who is responding at the extended abstract level can appreciate various possibilities of meaning around a group of words he has been able to identify. He is able to deal with second order relationships as well as direct concrete relationships, and thus, vocabulary permitting, his attempt at translation will be towards the normal language usage, not a literal meaning of the phrase.* These aspects are illustrated in the following item.

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* However, research into second language acquisition indicates that it is almost impossible for a person learning a language outside its native setting to be aware of the connotative meanings of words and phrases of that language. This seems reasonable since language reflects the continuous changes of its environment and its users. Although this finding is much more relevant to the problem of appropriate word selection in the foreign language, it may be reflected to some extent in translation also.

(1) Item 1. Translation from French: Henri Collard

The following passage was taken from a School Certificate Examination paper. The translations (by Year 10 students) provide examples of levels of response that can be identified as being at the multi-structural level, the relational level, or at the extended abstract level.

Translate into good English:

> "Henri Collard est arrivé à Marseille par le train du soir et s'est rendu immediatement à son hôtel. Il a dîné, puis, se setant un peu fatigué par une journée de chemin de fer, est monté à sa chambre et il s'est couché. Il a décidé de fumer une cigarette avant de s'endormir.
>
> Il avait déposé son paquet de cigarettes on sa table de nuit. Il en a mis une à sa bouche. Après avoir allumé la cigarette, il a rejeté son allumette lorsqu'il a eu un moment d'anxiété. Cette allumette enflammée, tombant sur le tapis, ne pouvait-elle pas causer un incendie? Henri y a jeté un coup d'oeil, il avait raison de la regarder; en effet, l'allumette brûlait toujours."

Examples of Responses

(i) "le train du soir"

1. Multi-structural

"the train of the evening"; "the train in the evening".

2. Extended abstract

"the evening train".

(ii) "sa table de nuit"

1. Multi-structural

"his table of the night"; "his table this night"; "his table for the night"; "his table at night".

2. Relational

"his night table".

3. Extended Abstract

"his bed-side table".

(iii) "cette allumette enflambée"

1. Multi-structural

"this match enflamed".

2. Relational

"this enflamed match"

3. Extended Abstract

"that burning match"; "this flaming match"; "this ignited match"; "that lighted match".

(iv) "a jeté un coup d'eoil"

1. Relational

"looked".

2. Extended Abstract

"gave a glance"; "cast a glance"; "glanced".

(v) "il avait raison (de la regarder)"

1. Multi-structural

"he had a reason".

2. Relational

"he was right".

3. Extended Abstract

"it was just as well".

(vi) "l'allumette brûlait toujours"

1. Multi-structural

"the match was burning always".

2. Extended Abstract

"the match was still burning".

(2) Item 2. Forming Rules from Specific Instances

The ability to work within an abstract but well-defined system has been shown (Inhelder & Piaget, 1958; Collis, 1973, 1975a) to be a characteristic of formal operational reasoning which is reflected in extended abstract responses. The student responding at the extended abstract level shows that he is able to define the rules or laws governing the system and to recognize inconsistencies and state explicitly why a certain system is inconsistent.

In terms of a student's responses in modern foreign language study, the student who is responding at the extended abstract level shows that he is capable of viewing another language as a unique system developed by and reflecting the people and their society. He demonstrates an ability to appreciate the structure of the language, including its rules of grammar, within the broader cultural and attitudinal context in which it is presented.

To illustrate this aspect of extended abstract responses and to obtain examples of students' responses at each level of cognitive development a simple system was presented and the student was asked to work within this system and explain the rule governing it. The material was presented as a class exercise designed to teach use of the indicative mood and the

subjunctive mood of the verb être. The students were in Year 10 and had not previously been given the rule.

"Examine the following:

Il est certain que Louis est intelligent.
Il est possible que Louis soit intelligent.
Il est douteux que Louis soit intelligent.
Il est évident que Louis est intelligent.
Il est sûr que Louis est intelligent.
Il est vrai que Louis est intelligent.
Il est étonnant que Louis soit intelligent.

Can you form a rule about the use of the subjunctive (soit) from these sentences?

Then complete the following:

Il est étrange que Louis ..... intelligent.
Il est clair que Louis ..... intelligent."

Examples of Responses

The student who is responding at the pre-extended abstract levels shows that he has difficulty defining the rule governing a system.

1. Uni-structural

(a) "Can't tell." (13 years)

2. Multi-structural

(a) "Because one might be feminine and one might be masculine." (13 years)

This response indicates that the student is substituting a familiar system instead of attempting to look at and define the given system. The student most likely guessed the answers for the two sentences which required completion and then gave the response shown here, which is a familiar rule based on his previous concrete experience with the language. It appears that the student responding at this level does not work within the constraints imposed, but goes back to previous concrete experience with data of a superficially similar type. The reasoning tends to be by analogy with a familiar system rather than within the given system.

3. Relational

(a) "'Est' is used when you are positive about something and 'soit' is used when you are not sure about something." (13 years)

A characteristic of responses at this level that is illustrated by this example is the tendency to formulate a rule by generalizing from a few instances and then to close on this formulation even if some of the data is not consistent with it. The student operating at this level forms a rule based on a few specific verifiable instances, but does not hold the

decision open while he considers all the possibilities and their interactions. He fails to seek an all-encompassing hypothesis against which he can test all sentences, instead he uses only sufficient data to make a reasonable (in his view) generalization. Successive sentences are then adapted mentally to "fit" (or may even be ignored).

At the relational level students show that they are aware that they must work within the framework defined by the sample sentences and generalize from these (i.e. not relate this system to some previous familiar rule), but they do not have sufficient awareness of the system, or cannot view the new system hypothetically free from the constraints of their "reality", to deduce the laws governing the system. They appear to have a "feel" for the consistency of the system without being able to express it explicitly. For example, one student, after completing the two sentences correctly, wrote "It just seemed right". It seems as if at this transitional stage the student can generalize sufficiently from his experience in language learning to attempt to work within the system, but he is unable to go beyond the information before him to make the necessary deductions about the variables involved.

4. Extended Abstract

(a) "'Soit' is used after impersonal expressions that indicate the personal opinion or doubt of the speaker."

In this response the student has gone beyond the immediate content to set up hypotheses and uses the data to test them. He views this exercise as an abstract system and uses each sentence as a necessary element to be used to test each hypothesis he constructs. His requirement for consistency in a system and his ability to recognize inconsistencies if they occur allow him to consider all possibilities carefully. By holding his decision open until he has considered all possibilities he is able to formulate and verify the rule or rules governing the system.

Implications for the teaching of modern languages

(1) Implications from Cognitive Development Theory

Perhaps the broadest implication for the classroom teacher is that the child's thought and language is qualitatively different from the adult's. Thus the teacher cannot assume that which is self-evident or even straightforward to him will be viewed that way by the student. The most important point to consider is that the student always needs to build on and modify his existing levels of response to develop his understanding of new material. Thus for example, only when the student has demonstrated a grasp

of the material by providing responses at the relational level will he be capable of generalizing from his concrete experiences and of then proceeding to responses at the extended abstract level. The higher levels depend on the lower ones and therefore concrete experience should precede learning from verbal explanations or written materials. It is unlikely for example that the pre-structural response would be indicative of a child completely intuitive in his approach or that the adolescent is completely verbal. Rather it seems probable that at a given period of development one mode of understanding will predominate over, but not exclude the rest. It should also be noted that familiarity with the material influences the understanding of the student. With unfamiliar material the student may give responses at a lower level than he is capable, and it is not until he has found a pattern in the new material and thus incorporated it into his thinking, or modified his thinking to accomodate it, that he will be capable of responding at his optimum level. This process will naturally occur at a different rate for each student and for most students the use of several specific concrete instances will not be sufficient to enable them to handle material at an extended abstract level. On the other hand deliberately choosing to present material at a totally concrete level, requiring no abstractions on the part of the student may disadvantage those students who are capable of giving extended abstract responses by masking the generalizations or patterns that they should be searching for. Judicious use of the SOLO Taxonomy and the "plus one" strategy would allow the teacher to avoid this danger.

The levels of response in the SOLO Taxonomy outlined here represent the best kind of response that people are capable of giving at the particular developmental stage or cognitive level. It does not follow that, because a child responds at a certain level, he must be taught entirely in a manner dictated by the method of thinking that is characteristic of that level. By teaching from the concrete grounds first, one is not insulting the intelligence of the student capable of extended abstract responses, but making it easier for him to apply his extended abstract structures to the problem. It is certainly true that it may not always be necessary to go through a long activity-oriented rigmarole, but it is also true that many people would acquire better extended abstract structures if they were led up to a particular concept via its concrete instances. Many teachers are perhaps rather too afraid of "spoon feeding": it must be remembered that the extended abstract response defines the upper limit of

one form of thinking, not the typical mode of adolescent cognitive functioning.

The results of all the studies in this area suggest that "experience is an important factor in promoting development" and that "each phase of development is necessary for the emergence of later more mature phases". (Peel, 1971) Children seem to be most interested and learn best when the experience is both familiar enough that it may be assimilated without distortion, and different enough to produce some degree of cognitive conflict.

(2) Implications from Research into Second Language Learning

In recent years language teachers have shifted the emphasis in language study from a more isolated study of vocabulary and grammatical structures towards an understanding of the foreign language within its broader cultural and attitudinal context. According to the current syllabus for French in N.S.W. schools the aim of the language teacher is to develop the student's appreciation of the language in a broader perspective, while still providing for the development of listening, speaking, reading and writing skills. However, in view of the levels of response outlined in this project it should not be assumed that students, particularly junior secondary level students, will approach the study of a foreign language free from the bias that arises out of the need to base all their thinking on current or recently prior concrete experiences and the need to relate aspects of another language totally to their own. The ability to view another people and their language hypothetically, free from constraints of personal experience, is a frame of reference which adolescents do not adopt until they have reached the level at which they provide extended abstract responses. To see one's own language as only one among many to which it bears certain relationships but from which it also differs must be brought out in many ways by the language teacher, using a variety of examples, to help students responding at pre-extended abstract levels overcome the limits of the system of concrete thinking they will otherwise tend to operate within. That the intellectual and cultural values of one's own community are not absolute but relative is easily integrated into the thinking of a student capable of responding at the extended abstract level. The chief mental characteristic demonstrated at this level is the capacity of transcending present time and space; this allows for the capacity of systematization. For the student responding at the pre-extended abstract level, an abstract system that may be similar to, but in fact different

from, his own reality is a view that he needs careful guidance to appreciate and incorporate into his thinking. Thus the underlying structures of the foreign language should be brought out using concrete illustrations and, where applicable, by contrast or comparison with the learner's native tongue. For example, a comparison of the use in English (perhaps not so frequent now) of the subjunctive mood after an expression of wish, e.g. "I wish it were so", helps the student accept and learn the use of the subjunctive mood in French. The importance of being able to give meaning to the structures of the foreign language, and the difficulties this view presents to the student not yet responding at the extended abstract level, have been noted by many researchers in language learning. "Realizing language structures (otherwise called 'grammatical learning') is necessary for adequate mastering (from within) of the language itself. Now this means being able to abstract the significant elements of the language, to generalize them as typical of that language, and accordingly to unify them into a synthetic outlook or system. Of course, such a high degree of conscious command of the language cannot be attained in the early stages of learning but only as learning progresses and the young learner's mind reaches higher stages of maturation. These characteristics of perceptual learning ought then to be kept in mind while dealing with the process of teaching and learning a language." (Titone, 1964) Language teachers generally are very aware of the difficulties students have learning grammatical structures or a formal system of language in isolation. This has led to the trend in language teaching towards the "direct method" which does away, not with the mediation of the pupil's native tongue, but with superfluous grammar. This approach allows the student to relate the foreign language to his own language but avoids the difficulties many students have if they are required to work within or learn a purely abstract system.

The importance of practice has been stressed in many research studies in foreign language learning. Because language is a practical skill, mere theoretical study does not guarantee an improvement in the usage of the language. There is no definite "transfer of training" from theory to practice in language learning. The following story illustrates this point. "It was reported that a teacher in Northern Ireland once asked a pupil in her class: 'What is wrong in the sentence: He has putten his feet on the table?' The youngster wrote: 'He's gone and putten putten and he should have putten put." (Titone, 1964) This error is typical of those arising because language study is presented as a collection of abstract grammatical definitions and rules which the student is not quite able to incorporate

into his cognitive structures because his stage of cognitive development does not yet allow meaningful responses within a purely abstract system. As many authors following or commenting on Piaget's theory remark, the increased ability to abstract, emerging in early adolescence, is still far from being classified as "pure abstract thinking", yielding extended abstract responses, for it rises out of and has its basis in concrete thinking. This provides an immediate implication for teaching method: the study of grammar may become a means of refining and articulating abstract thought but it must not be forgotten that grammatical relations are essentially divorced from the concrete (Titone, 1964) and if they are presented as such, they are not likely to be seen as meaningful by students not yet capable of responding at the extended abstract level.

Summary of Some Related Research Findings

How the individual learns both native and subsequent languages has interested educators and psychologists for a long time, however it is only since the Second World War that the scientific study of language learning has become as intensive, extensive and widely reported as it is today. This is especially true in the United States of America where much scientific research into the psychological processes of language learning is currently in progress. Although there are proponents for various theoretical bases and although few conclusions can be regarded as definitive a number of implications for foreign language teaching are beginning to emerge.

Some of the broad areas of study into the processes of second language learning include:

(i) how a second language is acquired - in a similar way to the native language or by contrasting the new language with the native language,

(ii) the effectiveness of various teaching methods, optimum proportion of explanation to drill at various ages and the effects of successive versus simultaneous learning of two foreign languages,

(iii) the influence of setting - home, classroom and native settings,

(iv) attitude variables, language aptitude and motivation.

This limited outline gives some indication of the awareness of researchers of the many variables involved in foreign language learning and of the complexity of the underlying processes. Although many research studies use learning theory as a theoretical base for their experimental designs, there has been very little research where the students' thinking in foreign

language learning has been examined in the light of their stages of cognitive development. To some extent this is surprising because many studies seem to assume implicitly that the stage of cognitive development of the individual is a general factor underlying the process of language acquisition.

However a research study (Wittwer, 1959, cited by Titone, 1964) designed to discover at what age the child or adolescent is capable of formal reasoning and abstract thinking used the grammatical analysis of language to demonstrate formal thinking capacity. Wittwer classified grammatical analyses into two divisions: (a) functional analyses (which are needed for the comprehension of the meaning of the language text taken both as a whole and in its significant elements), and (b) reflex analyses (which are not altogether necessary for understanding the basic meaning of a language text, but require conscious consideration of the constituent parts of speech). His results indicated that only around the age of 13 years does the need for grammatical explanation arise in the pupil. Before that period, as a rule, the child's mind is not yet ready for reflex analyses of the elements of speech which would imply the actual use of abstract reasoning (a characteristic of thinking at the formal operational stage of cognitive development, and a prerequisite for responding at the extended abstract level). He also noted that since there is current controversy about traditional grammar categories: teaching based on these may become "language instruction on false premises". Teaching needs to be derived concretely out of actual language usage through an inductive process made relevant to practical learning. In the course of this process theoretical interpretation is kept to a minimum.

Research into how a second language is learned and thus how it can be taught most effectively still presents various theoretical bases and some conflicting experimental results. This reflects the complexity of the learning process in second language acquisition, but has led to further research designed to identify some of the factors or components determining how an individual learns a subsequent language. An historical approach provides the simplest exposition of current research into how a foreign language is learned.

Early studies tended to assume that the individual learnt by contrasting the new language with his native language. This appeared to account for the problems adults had (caused by interference) and gave rise to the "contrastive analysis hypothesis" as a theoretical base for research. This hypothesis states that while the individual is learning a second

language he will tend to use his native language structures as a basis to organize structures in the new language. The contrastive analysis hypothesis gave rise to a number of theoretical research papers by linguists who studied language learning in terms of a comparison of the grammatical structures of both languages. This research provided an inventory of areas of difficulty and potential errors that were assumed to occur as a result of interference in the learning of the second language from the habits of the first. However, pointing out potential difficulties was hardly seen as a help by teachers since they were already well aware of where students had difficulties. They were more interested in research on how to deal with these difficulties.

Researchers using contrastive analysis as a technique to investigate foreign language learning tended to assume that errors were the result of interference. This gave rise to a field of research that may be termed "error analysis". Initially its orientation was with interference errors but then a second theory of language acquisition was generated, namely that second language learning is similar to or parallels first language learning. This theory would appear to apply mainly to the younger child because the older child or adult obviously begins with a highly articulate verbal repertory, which he may tend to use in the new learning situation. This may constitute an asset as well as a liability in that the two systems may cooperate but also may at times conflict. This hypothesis is also more readily applied to learning that takes place in a setting that is similar to that for first language acquisition and thus may not be entirely appropriate to describe the classroom situation.

In a study designed to examine these two theoretical bases (learning by contrasting native and foreign languages, or learning the foreign language in a similar sequence to native language learning) Dulay and Burt (1974) used error analysis and a classroom setting to throw light on how children learn a second language. They attempted to determine whether the syntactic errors children make while learning a second language are due to native language interference or to developmental cognitive strategies as has been found in first language acquisition. Their technique involved looking at the errors Spanish children made when learning English.

The subjects were 179 Spanish speaking children, five to eight years old, who were learning English as a second language. The children's speech was collected by their teachers using the "Bilingual Syntax Measure" (Burt, Dulay and Hernandez, 1973). The authors selected those utterances that contained errors that could be classified without question as interference or non-interference errors. This gave six syntactic structures that are

different in Spanish and English. The errors were then classified into three categories: developmental (those errors that are made by children learning English as their native language), interference (those errors that reflected native language (Spanish) structure) and unique (those errors that are neither development nor interference errors but which appeared in the sample).

The results indicated "that first language interference accounted for only 4.7% of the children's errors, while developmental strategies accounted for 87.1% of the errors." The authors suggested an analysis of the unique errors (8.2%) may also provide useful insight. They pointed out that children's errors are not indicators of faulty learning, but that errors are a necessary condition in the learning process.

This view of errors, not as indicating faulty learning (or teaching), but as a necessary part of the learning process has been emphasized by Corder (1967). He distinguished between those errors which are a product of chance circumstances, slips of the tongue or pen, which he called performance errors or mistakes, and those errors which reveal the underlying knowledge (or lack of knowledge) of the language at that point in time, which he called the transitional competence of the learner. Corder postulated that errors of competence are systematic, and thus they provide evidence of the system of language the learner is currently using (i.e. has learned) at that time in his process of acquiring the language structures. Errors of competence may be considered significant for a number of reasons: firstly they provide information for the teacher about how the learner has achieved (and how far he has to go), secondly an analysis of the sequence of competence errors may provide insight into how language is acquired, and thirdly they are indispensable to the learner himself because feedback about errors provides a device by which he can learn. It is a way of testing hypotheses about the language system he is learning. That the relevance of this third point is obvious to language teachers is evident by the heavy emphasis placed on showing students their errors, correcting all written work, and in fact encouraging students to learn by checking over their errors. It is also obvious that a correct statement need not imply that the student has mastered all the underlying structures: he may simply be repeating a heard utterance.

Although this "testing of errors strategy" implies the same processes are followed in first and second language learning an important distinction should be made. While the learner of the first language may be testing an unlimited number of hypotheses about the nature of the language he is

learning, the task for the second language learner is much simpler: the only hypothesis he needs to test are, "are the systems of the new language the same or different from those I know, and if they are different what is their nature?" (Corder, 1967) Evidence for this is that a number of learner's errors have been ascribed to "interference" from the mother-tongue. However in terms of Corder's hypothesis these errors may be viewed as signs that the learner is investigating the systems of the new language in relation to his native language, rather than regarding them as persistence of old habits.

Thus it seems reasonable to conclude that second language acquisition cannot be described simply as either "the same as first language learning" or "by a contrast process with the first language". The underlying thought processes require a more complex description that incorporates not only strategies the learner uses but also the method of processing available to him determined by the level of cognitive development at which he is operating, which is indicated by the quality of his responses as judged in terms of the SOLO Taxonomy. Obviously his stage of cognitive development, indicated by his SOLO level, will help to determine the learning strategy he uses. If he is capable of responding at the extended abstract level then the formation of abstractions and generalizations are an integral part of his reasoning ability, and he will apply this to his organization of the structures in the foreign language he is learning. If he is capable only of operating at pre-extended abstract levels then the need to base his learning on previous concrete experience will be reflected in his responses.

It could be argued that the method of teaching determines how a student learns a foreign language, and that the contrastive analysis hypothesis simply reflects the predominant method of instruction of that period - namely that the formal grammar of the native language was taught and then the foreign language was presented as a system of formal grammatical structures that was similar to and different from the native language. However recent research evidence suggests that to a large extent the method of presentation of material in language study does not determine the method of learning. The student tends to organize (or fail to organize) the material for himself. Thus it seems as if the level of cognitive development at which he operates is one of the major factors determining how he thinks about and structures the material and thus how he learns. However these two factors need not be independent in the learning situation. The "good" teacher will present the material in a way that allows it to be most effectively organized and assimilated by the student. If the "teaching"

and "learning" factors are cooperative then the student's learning should be optimal, and the SOLO Taxonomy provides a useful device whereby the teacher can help to ensure that these factors are brought into cooperation.

Another study that has implications for the teaching of foreign languages and reflects the importance of the students' stages of cognitive development in the learning of language structures was conducted by Reeves (1975). Reeves used the Pimsleur Language Aptitude Battery in her assessment of some factors influencing the study of German at the junior secondary level. The language analysis section of this battery tests the pupil's ability to discover grammatical relationships and to select from a number of multiple choice items the correct version of various sentences by applying the "rules" which he has discovered. Although the subjects were all year 8 students, Reeves found a wide range of scores on this section. This data supports other research in this area in that there appears to be only a weak relationship between the language analysis test score and a pupil's measured I.Q. Reeves emphasized the implications because many educators tend to assume that grammatical analysis ability has a high correlation with I.Q. Reeves noted: "If it is true that many pupils have difficulty, at least initially in becoming aware of underlying structures and in developing and applying generalizations and that each pupil's ability to carry out these operations successfully develops at varying rates and at different ages, then language teachers must be constantly aware of the confusion which they may be creating by quoting grammatical rules in what may seem unintelligible terms to their pupils and which many pupils will not be able to apply. Furthermore, for teachers of German, the difficulty which many pupils experience in the language analysis sub-test in discovering structural relationships through changes of inflection, would seem to indicate that the greatest care should be taken in introducing learners gradually to the various cases and other linguistic areas involving inflections." (p. 83) This provides support for the idea that the ability to analyse formal structures in language depends to a large extent on the student's level of cognitive development: the language analysis sub-test measures the ability to develop rules and generalize from these, so it would seem that a student would need to be responding at the relational level or beginning to respond at the extended abstract level to score well on this section of the battery. This would explain the wide range of scores obtained from year 8 students because this age group is probably the most diverse in terms of levels of response, ranging from uni-structural through to extended abstract depending both on

the material and the student's willingness to respond at the highest level of which he is capable.

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SECTION D

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